Theory Guide

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KODAK X-OMAT 460 RA Processor

HEALTH SCIENCES

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SECTION 1
Product Description

The *Kodak X-OMAT* 460 RA Processor is a general purpose radiographic processor. It uses a conventional roller transport system to accommodate both roll and sheet film.

The 460 RA processor incorporates several new features. These include microprocessor control, an improved operator interface, improved error detection and indicators, and "smart" replenishment. The 460 RA processor also provides four, user-selectable film cycles that run at four default transport speeds:

- K/RA
- Rapid
- Standard
- Extended

Each cycle has default parameters for transport speed, developer and fixer replenishment volumes, and developer, fixer and dryer temperatures. These default parameters are stored in memory, but can be modified by the user. A battery supplies uninterrupted power to memory so the parameters do not have to be reentered each time the processor is deenergized.

All cycles, except for the K/RA cycle, use standard RP chemistry and film. The K/RA cycle, however, requires the new RA chemistry and film.

Processor Operation

The operator feeds patient film from the feed tray into the processor. The film is then transported through the machine by a network of motor-driven rollers known as the film transport assembly.

The film travels through 3 tanks where the following solutions are applied:

(1) **Developer**

This solution converts the invisible latent image on the film to a visible image.

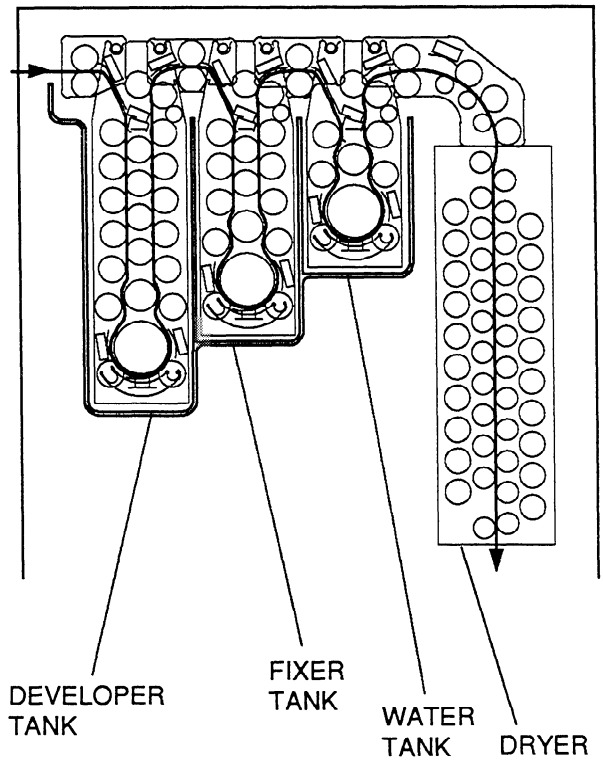
(2) **Fixer**

This solution stops the continued development of the visible image by removing unused silver halide crystals from the film. The RP fixer also increases the permanency of the visible image by hardening the emulsion. The RA fixer, however, does not include a hardener because the film has a pre-hardened emulsion.

(3) **Water**

The water removes all excess developer and fixer from the film, which prepares the film for drying. This ensures a permanent image on the film.

Upon exiting the wash tank, the film is transported through a dryer. In the dryer, a blower circulates warm air across the surface of the film. The dry, processed film then exits the processor.



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The processor functions are monitored and controlled by the following circuit boards. The role of each circuit board is described in more detail within the processor functional descriptions later in this publication.

(1) interface circuit board (200 circuit board)
(2) display circuit board (300 circuit board)
(3) microprocessor circuit board (500 circuit board)
(4) film accumulator circuit board (5600 circuit board)

While the film moves through the various chemical tanks, the processor is controlling several other functions. These functions create optimum processing conditions in the tanks:

- **Maintaining the Correct Temperature of the Developer and Fixer**

  This function is accomplished by controlling the duty cycle of the developer heater and by turning the fixer heater on and off. The heaters are located inside the developer and fixer thermowells.

- **Cooling the Developer**

  This function is accomplished through 2 solenoids; the water supply solenoid and the cooling dump solenoid. When the water supply solenoid energizes, water is supplied to the wash tank. When developer cooling is necessary, the cooling dump solenoid deenergizes, allowing water from the wash tank to flow into a heat exchanger at the bottom of the developer tank and then to a drain. At the same time, the water supply solenoid continues to supply water to the wash tank to keep the wash tank full.

  The water supply flows at a rate of 1.5 gallons per minute, while it drains through the heat exchanger at a rate of 1.3 gallons per minute. The difference in flow rates ensures that the wash tank will remain full during the developer cooling operation.

- **Replenishing the Developer and Fixer Tanks**

  This function is accomplished by activating the developer and fixer replenisher pump each time 0.15 sq meters (238 sq in.) of film are measured by the film accumulator. The amount of solutions added to the tanks during each replenishment cycle is specified by the user. External replenisher tanks or an automixer is connected to the processor to supply the developer and fixer solutions.

- **Maintaining the Correct Temperature in the Dryer**

  This function is accomplished by energizing an exhaust fan, blower motor and air heaters to circulate warm air across the surface of the film. A dryer thermistor senses the temperature of the air in the dryer, and a resettable safety thermostat senses abnormal temperatures.

- **Transporting the Film through the Processor**

  This function is accomplished by energizing the main drive motor when film is detected by the film accumulator. The drive motor drives the rollers that transport the film from the entrance, through the processor and to the exit.

  The drive motor controller provides a feedback signal which allows the processor control software to compensate for varying torque loads and maintain a constant transport speed.

- **Diagnostic Features**

  The processor also includes special software that allows it to interface with a laptop (or portable) computer. This feature increases diagnostic capabilities and provides quick updating of processor software. With the laptop, new software can now be downloaded directly into the processor, rather than installing new memory chips.

SECTION 2
System Initialization

When power is applied, or the processor is reset, the software checks the setup and operation of the processor. The system initializes variables, I/O ports, serial communications ports, the film accumulator and the display panel.

The initialization begins with a self-check to verify correct operation of the processor. The self-check verifies the:

- Operation of the internal RAM and external RAM
- Checksum of the main program EEPROM
- Checksum of the bootstrap EPROM
- Operation of external input/output devices

If the self-check locates an error, the processor will display a fatal E001 error. If the self-check is successful, the initialization continues and the processor:

(1) energizes the water supply solenoid, allowing water to flow into the processor.

(2) energizes the dryer blower and air heater.

(3) checks the developer and fixer solution levels. If the levels are not correct, the replenishment cycle activates and the tanks are filled. If the level does not reach the correct level within 2 minutes, a tank fill error occurs.

(4) energizes the recirculation pump after the solutions reach their operating levels. This circulates the developer and fixer solutions through the thermowells where they are heated, if necessary. A ready condition will be displayed when the solutions reach their operating temperatures. If the temperature, however, increases too slowly, an error condition occurs.

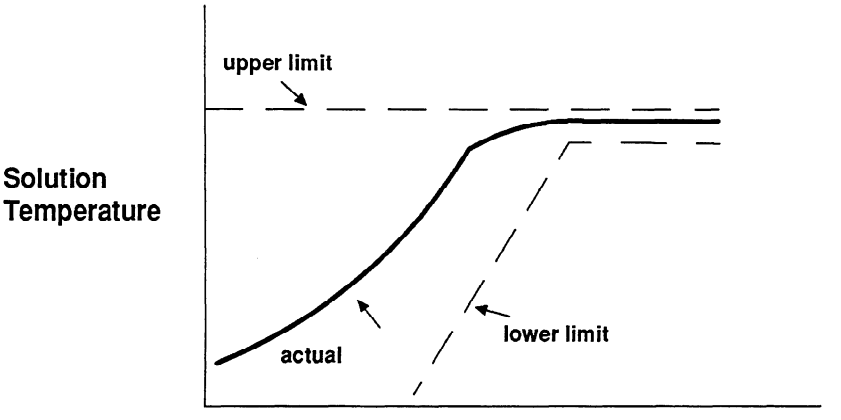
The microprocessor uses algorithms and controls to monitor the temperature of the solutions. The temperatures should increase at a normal rate within a 15 - 20 minute time period. The chart below illustrates the relationship between temperature and time.

(5) energizes the exhaust fan if it is wired for continuous operation.

If the initialization sequence is completed successfully, the processor will display a "Ready" message.

NOTE

The status LED DS7, located on the 500 circuit board, flashes on and off at 1/2 second intervals when the software is operating correctly.



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SECTION 3
Film Transport

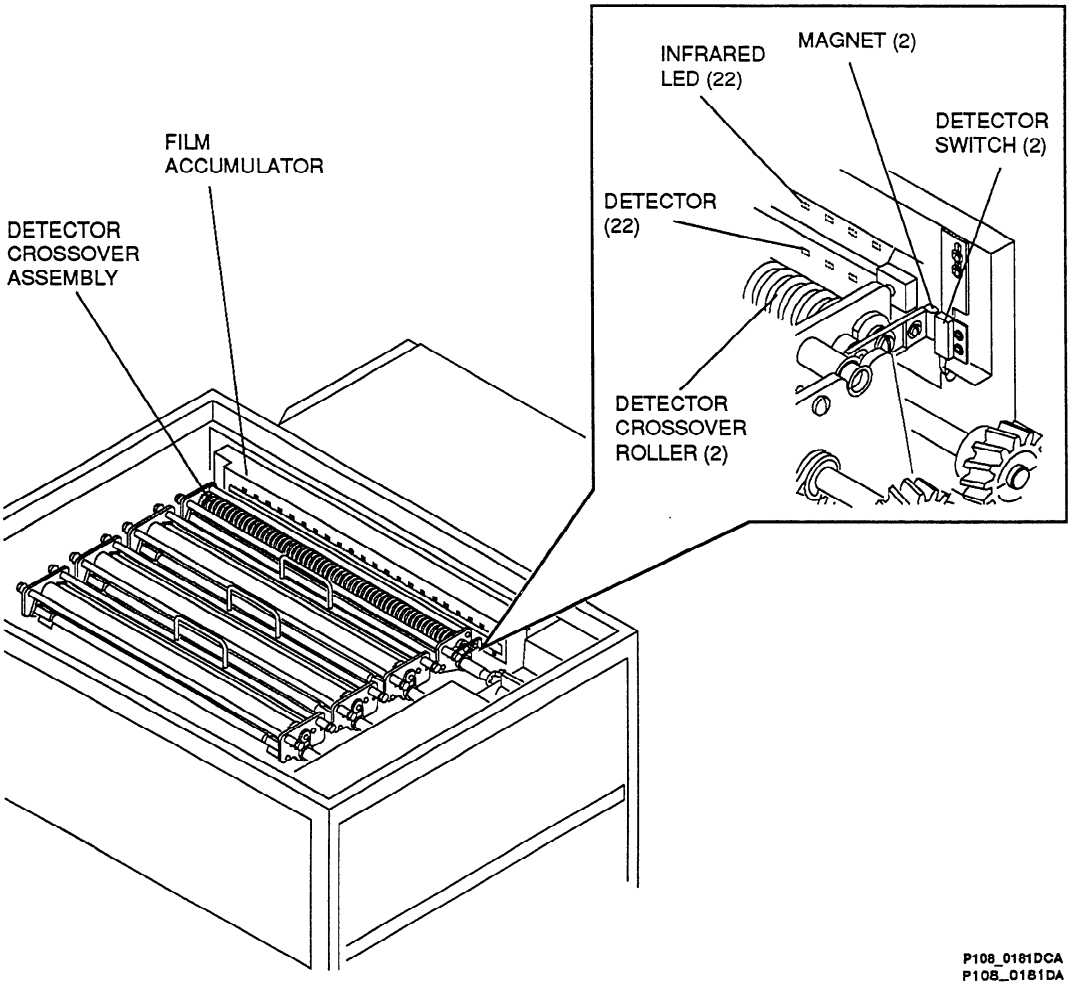
Film Detection

Now that the processor is ready, the operator can process film. The operator loads the exposed patient film through a slot at the feed end of the processor. As the film enters the processor, it passes through a film accumulator. The film accumulator has 22 infrared LEDs and detectors that sense the presence of film. The processor then exits the standby mode and enters the operating mode. If an error exists in the processor, the alarm will sound twice.

When the processor enters the operating mode, the following occurs:

- the main drive activates
- the wash water supply solenoid energizes, providing water to the wash tank
- the dryer blower and heater energize
- the safelight receptacle turns off if the safelight receptacle mode has been activated

The lead edge of the film then causes the entrance rollers on the detector crossover assembly to separate. As the rollers move up, the magnets on either end will actuate one or both of the detector switches S1 and S2. This signals the film accumulator to begin sensing film area.



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Film Accumulator (5600 Circuit Board)

This section provides a detailed explanation of the film accumulator operation. The film accumulator begins sensing film area when the detector crossover rollers actuate the detector switches.

The film accumulator measures film area by pulsing 22 infrared LEDs at a known rate based on the film transport speed. As the film passes through the film accumulator, some of the pulses will be blocked by the film. The number of blocked pulses varies, depending on the width of the film. The film accumulator counts the undetected infrared pulses and calculates the area of film being processed. The information is sent to the 500 circuit board via a digital communication link. The microprocessor then uses this information to calculate replenishment pump on-times.

When the accumulator stops sensing film, the processor advances the film counter by 1 and initiates the following timing sequences:

(1) **3-Inch Spacing Sequence**

This sequence lasts for the amount of time it takes the processor to transport the film 3 inches. When the sequence ends:

- the alarm sounds once, indicating that another film can enter the processor
- the safelight receptacle turns on if the safelight mode has been activated

(2) **Film Clear-Out Timing Sequence**

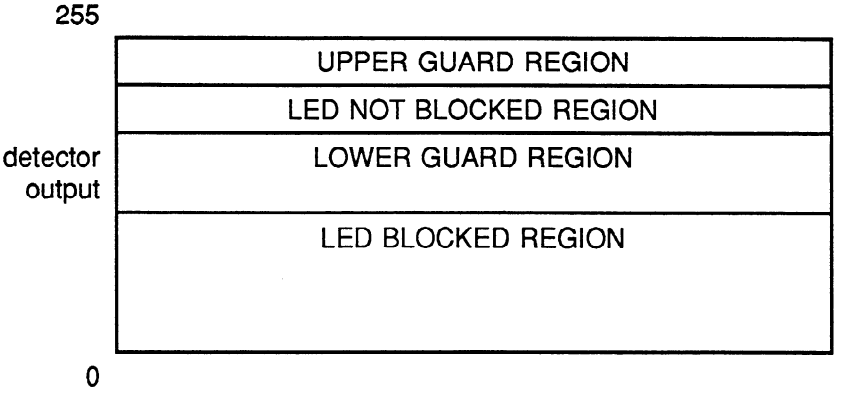
This sequence determines when the film should exit the processor.

The film accumulator accomplishes its task by performing several internal functions explained below.

Scanning Mode

The film accumulator performs an analog-to-digital conversion on the output of the individual infrared detectors. This is called the scanning mode of the film accumulator. If the output of a detector falls into the range labeled LED BLOCKED REGION (see the table below), the software assumes that film is between the LED and infrared detector. If the output of a detector falls into the range labeled LOWER GUARD REGION, LED NOT BLOCKED or UPPER GUARD REGION, the software will assume that no film is between the LED and detector.

Since the film passes through the device at a constant speed, and the LEDs are pulsed at a known rate, the film area is determined simply by adding the number of times each LED/detector pair is blocked by the film. After an amount of film equal to the film threshold is detected, a command is sent to the 500 board indicating that 0.15 sq meters (238 sq in) of film have been detected.



Run-Time Calibration

The film accumulator automatically calibrates itself to compensate for performance changes caused by dirt, age or environmental conditions. The calibration feature is implemented by adjusting the power to each of the LEDs if the output of an LED/detector pair falls outside the predetermined range (LED NOT BLOCKED REGION) when film is not present.

When the output of a detector lies in either the UPPER or LOWER GUARD REGIONS, the software will either increase or decrease the power to the associated LED so the next time the LED/detector is sampled, the output will fall closer to the LED NOT BLOCKED REGION. The power is only increased or decreased in increments of 0.4% to prevent overcompensation.

Start-Up Calibration

The film accumulator calibrates itself at start-up by supplying each LED with minimum power and increasing it until each detector output falls into the LED NOT BLOCKED REGION. The device assumes there is no film present between the LED/detector pairs when the calibration is done.

NOTE

Do not allow external light to fall on the sensors during the start-up calibration.

Scan Parameters

To ensure accurate area measurement, the rate the LEDs are pulsed is fixed for any given processor transport speed. To minimize the amount of infrared light exposure to the film, the LEDs are turned on for a period of approximately 20 microseconds. This ensures that the film accumulator will not fog laser imaging films.

Error Detection

The software continuously monitors all LED/detector pairs for proper operation. It will indicate an error when one or more pairs are not operating. The following two errors will cause the processor to display an ERR 137 error code:

- **Calibration Error**:

  If an LED/detector pair cannot be calibrated within the specified limits either at start-up or while in scanning mode, the data from that pair will not be used in film area computation.

- **Blocked Error**:

  If an LED/detector pair appears blocked for a period exceeding the time required to transport a 500-foot length of film, the pair is considered inoperable. Information from the pair will not be used in film area computation.

- **Communication Error**:

  This error occurs when there is no communication between the 5600 Circuit Board and the 500 Board.

Drive System

Now that the feed signal has been sent, the circuit for the drive system activates. Let's examine the drive circuit, which is illustrated on the opposite page.

The cover interlock switch is one of two conditions that must be met before the drive engages. If the cover is removed, the transport driver is disabled and an error code, ERR 128, is displayed. The transport driver is also disabled if the operator has accessed the "GO TO SETUP" option from the main menu. The transport driver will start when the cover is installed and the operator returns to the main menu.

The second condition requires that the 5600 circuit board (film accumulator) detects the presence of film. The 5600 circuit board sends a command to the 500 circuit board, which starts the drive.

The 200 circuit board from the interface panel, if connected to other equipment, also provides input to the microprocessor. This input, which travels through the processor interface connector (PIC) or electrical interface on the control panel, tells the processor to exit the standby mode.

Speed Control

Now the microprocessor can engage the drive. The quad power supply supplies +24 V dc through fuse F2 to the drive motor controller. The 500 board then outputs a variable speed value (from 0 - 6 V dc) to the speed input terminal of the drive motor controller. The speed value varies, depending upon the speed of the selected processing cycle.

The voltage to the speed input terminal is varied by a digital to analog converter chip on the 500 board. The digital speed value is written to the D/A converter, where it is converted into an analog value (0 - 6 V dc). The higher the digital value, the higher the analog value. The analog value then enters the speed input terminal, which causes the motor to change speed. The higher the analog value, the faster the speed of the motor.

Because rapid changes in motor speed cause excessive current draw, the full speed value cannot be written immediately to the digital to analog (D/A) converter. Instead, the motor is gradually increased to the desired speed. This is accomplished by ramping the D/A value from 0 to the set speed value. This ramping takes approximately 1 second to complete.

Speed Check

The drive motor is a brushless, variable-speed, DC motor. It contains a pulse generator which sends feedback signals to the motor controller, indicating the speed of the motor. The motor controller converts the analog signals into digital signals, and sends them to the 500 circuit board. The microprocessor uses this information to either increase or decrease the speed of the motor until it is correct.

The feedback pulses are produced at a rate of 12 per revolution of the motor. The pulses are counted by the microprocessor.

Transport Errors

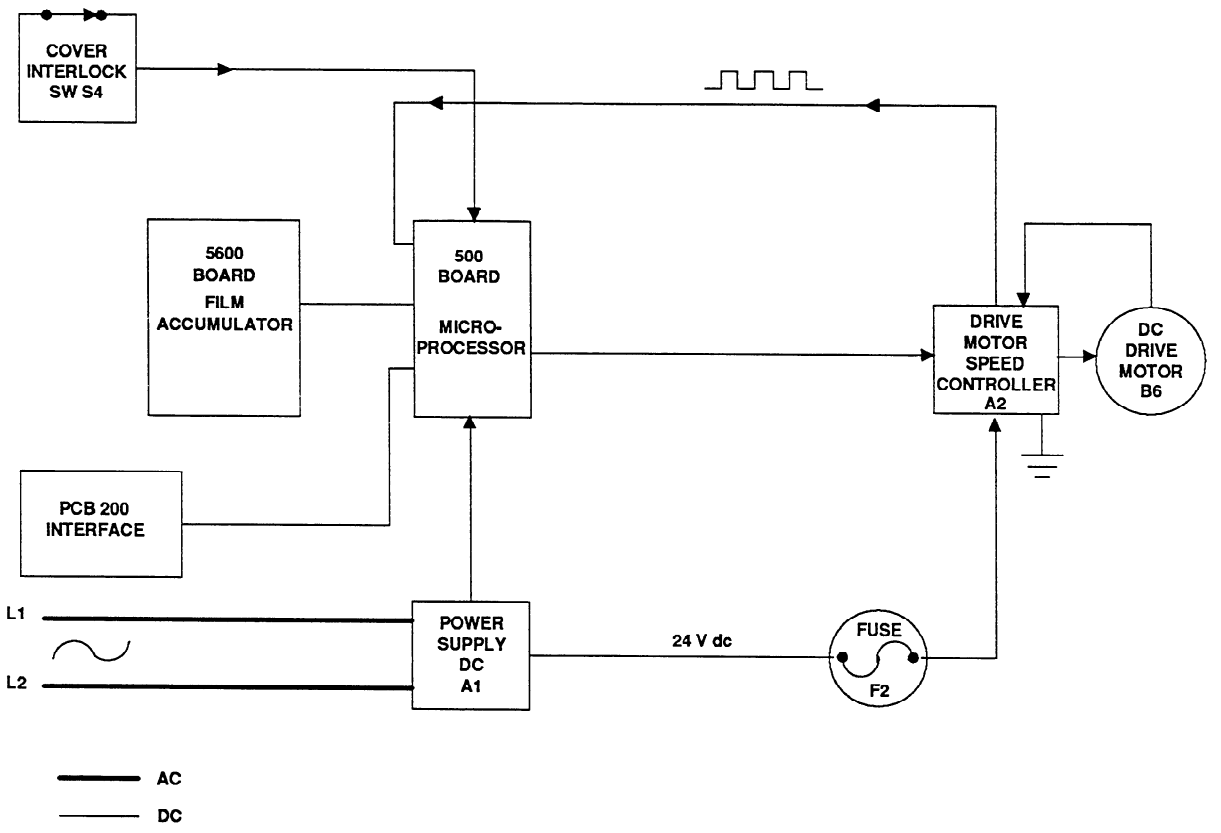
- **Inoperative Transport Error (Fatal Error ERR 004)**

  If the feedback pulse count for one second is less than 5, the count value is calculated as zero transport speed and an inoperative transport error occurs (fatal error ERR 004). An ERR 004 also occurs if the D/A converter count reaches its maximum or minimum value (255 or 0).

- **Loss of Transport Speed Control Error (Nonfatal Error ERR 041)**

  If the speed of the motor is 3 inches/minute above or below the setpoint for a period of 10 seconds, a loss of transport speed control error (nonfatal error ERR 041) will occur.

BLOCK DIAGRAM
D.C. DRIVE MOTOR CONTROL



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Drive Components

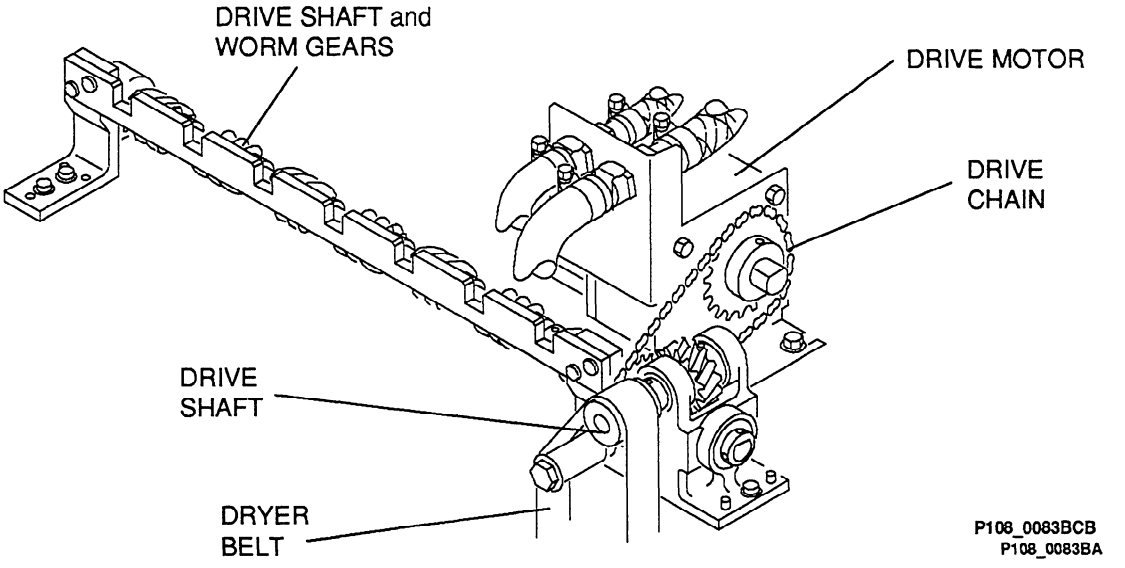
The drive motor supplies drive to a network of rollers called the film transport assembly. The drive system is separated into two sections; one for transporting film through the tanks, and one for transporting film through the dryer.

- **Transporting Film Through the Tanks**

  A drive shaft containing several worm gears provides the drive for transporting film through the processing racks. Each worm gear meshes with a drive gear on the film transport assembly. When the drive motor energizes, the drive shaft and worm gears rotate, transferring drive to the drive gears. The drive gears then drive the transport rollers on each rack assembly.

- **Transporting Film Through the Dryer**

  A drive shaft and belt provide drive to the dryer. The belt transfers drive to pulleys located on one end of every roller shaft. The pulleys then rotate the roller shaft, and the rollers.



Film Transport Assembly

Now that drive is supplied to the film transport assembly, the detector crossover assembly transports the film into the processor. When the trailing edge has traveled 7.6 cm (3.0 in.) into the processor, the alarm on the film accumulator will sound. This indicates that another sheet of film can be fed into the processor.

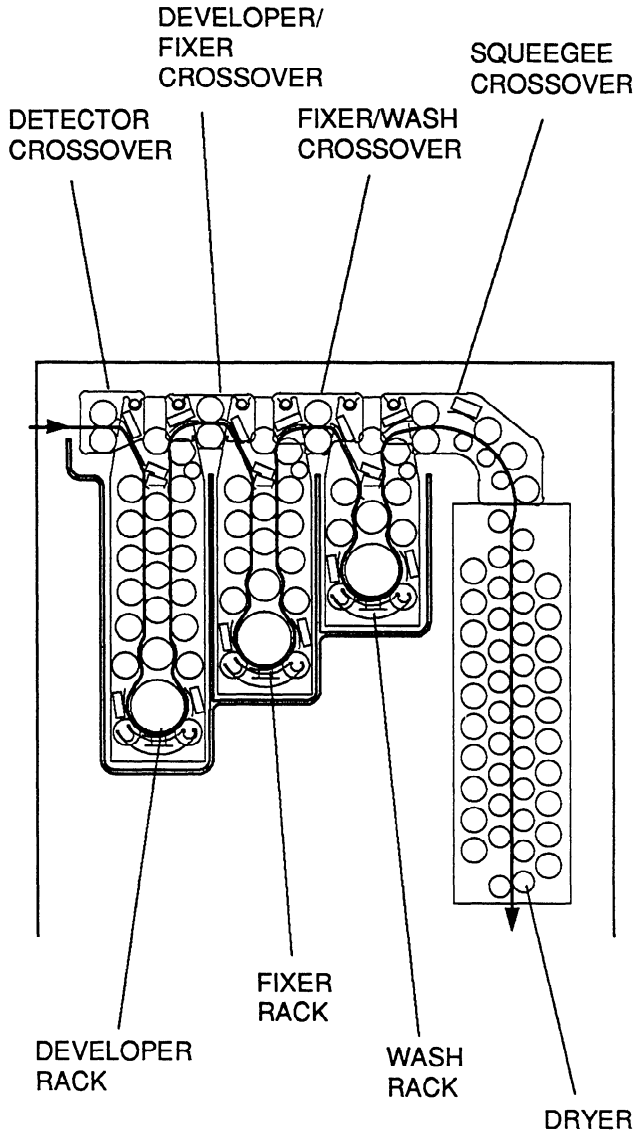
NOTE

A double sound from the alarm is also possible. This occurs if the processor has an error condition when the film accumulator detects the presence of film.

The film is transported to a developer rack, a fixer rack, and a wash rack. The racks consist of a series of rollers driven by chain and gear mechanisms. Although the developer and fixer racks are similar, they cannot be interchanged. This is especially important to prevent chemical residues from contaminating other solutions.

Between each rack is a crossover section that transports the film between racks. The pressure applied by the rollers also removes any remaining solutions from the film surface before it enters the next rack.

When the film leaves the wash rack, it passes through the squeegee crossover into the dryer transport. The squeegee crossover spreads remaining droplets of water across the film surface, to encourage fast, uniform drying. The rollers in the dryer then move the film through the dryer and out the processor into the receiving tray.



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SECTION 4
Processing

Overview

As the film moves through the film transport assembly, the film passes through several tanks where the film is processed. The processing procedure involves 4 different stages. These stages and how they are controlled are described in this section.

Developer Tank

The film enters the developer tank first. In this tank, a developer solution converts the invisible latent image on the film to a visible image.

The processing tank contains 2½ gallons of developer solution. The solution in the external container is a mixture of developer chemical and water. The solution is replenished automatically from an external tank of solution or automixer. For more information about replenishment, see page 36.

Developer Recirculation

The developer recirculation pump circulates the developer solution continuously through a thermowell where it is heated when necessary. The developer also passes through a filter.

The developer recirculation pump is magnetically coupled with the motor. The developer and fixer recirculation pumps use the same motor.

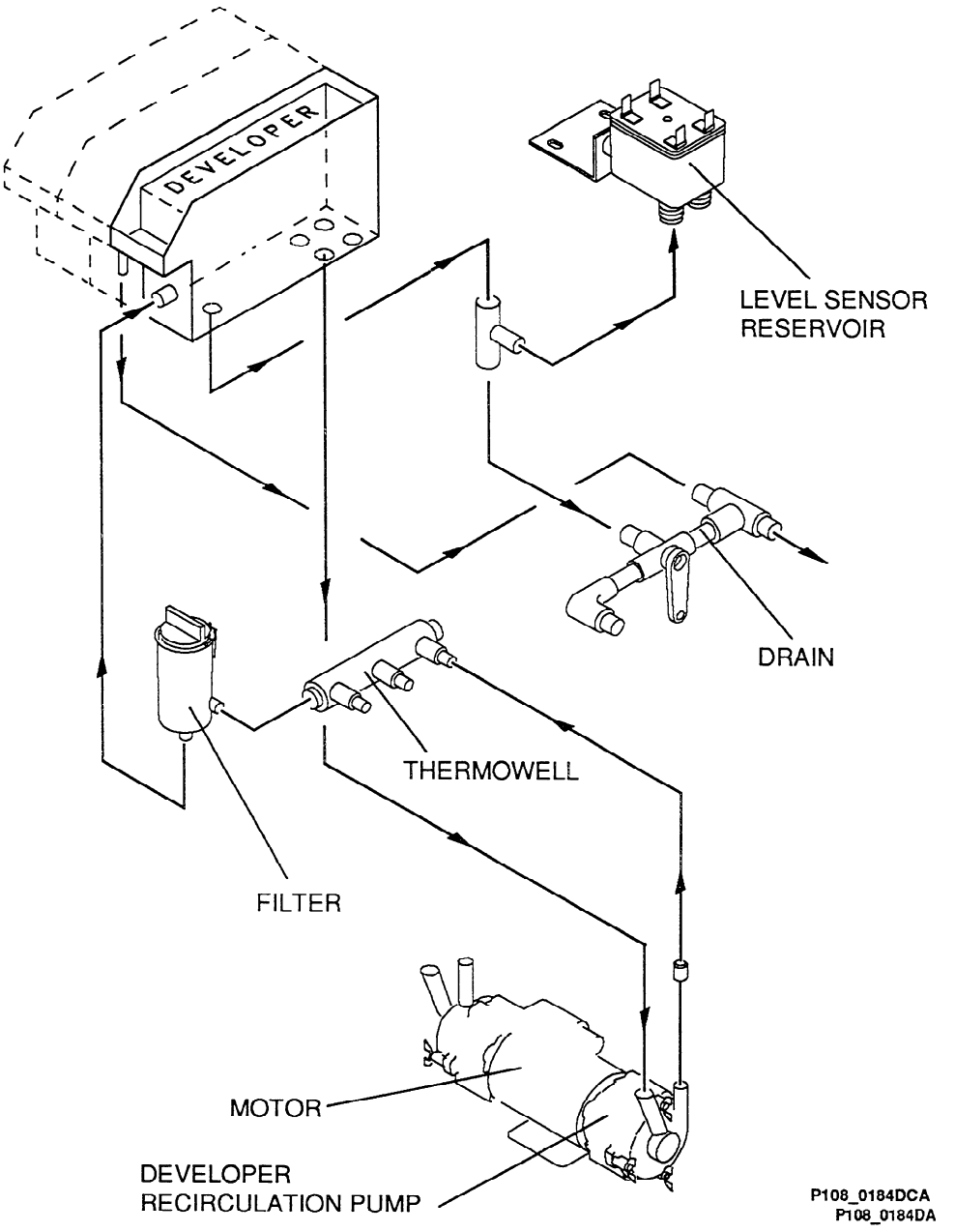
Recirculation takes place only when both the developer and fixer tanks are full. A full condition is detected by a sensor in the level sensing reservoir. The sensor uses 2 probes to monitor the level of solution in the reservoir.

Tubing connects the developer tank with the reservoir. The level of solution in the reservoir corresponds with the level of solution in the tank. When the level is correct, the 2 developer sensor probes are immersed in solution, providing a path to ground. This lowers the resistance of the circuit. The microprocessor, which monitors the circuit, detects the lowered resistance and determines a correct solution level. When the level is not high enough to cover the probes, the resistance of the circuit is higher. The microprocessor detects the high resistance and determines a low level condition.

Developer Level Detection

The developer solution detect function is controlled by a multiplexer circuit. The developer level sensor and the developer thermistor channel are selected at the same time. The solution level input is read just before the temperature control, analog-to-digital (A/D) converter is read.

- If the level sensor is not immersed in developer solution for 10 consecutive readings (approximately 5 seconds), the solution is considered low.
- If the level sensor is immersed in solution, the developer solution is considered at the operating level.



Developer Recirculation System

Developer Recirculation Control Circuit

Now that you are familiar with the components, let's review the control circuit for the developer recirculation. A diagram of the circuit appears on the opposite page.

Before recirculation will begin, both the developer and fixer solutions must be at the correct levels in the tanks. This occurs when the probes for the developer and fixer level sensors are immersed in solution, providing a path to ground.

NOTE

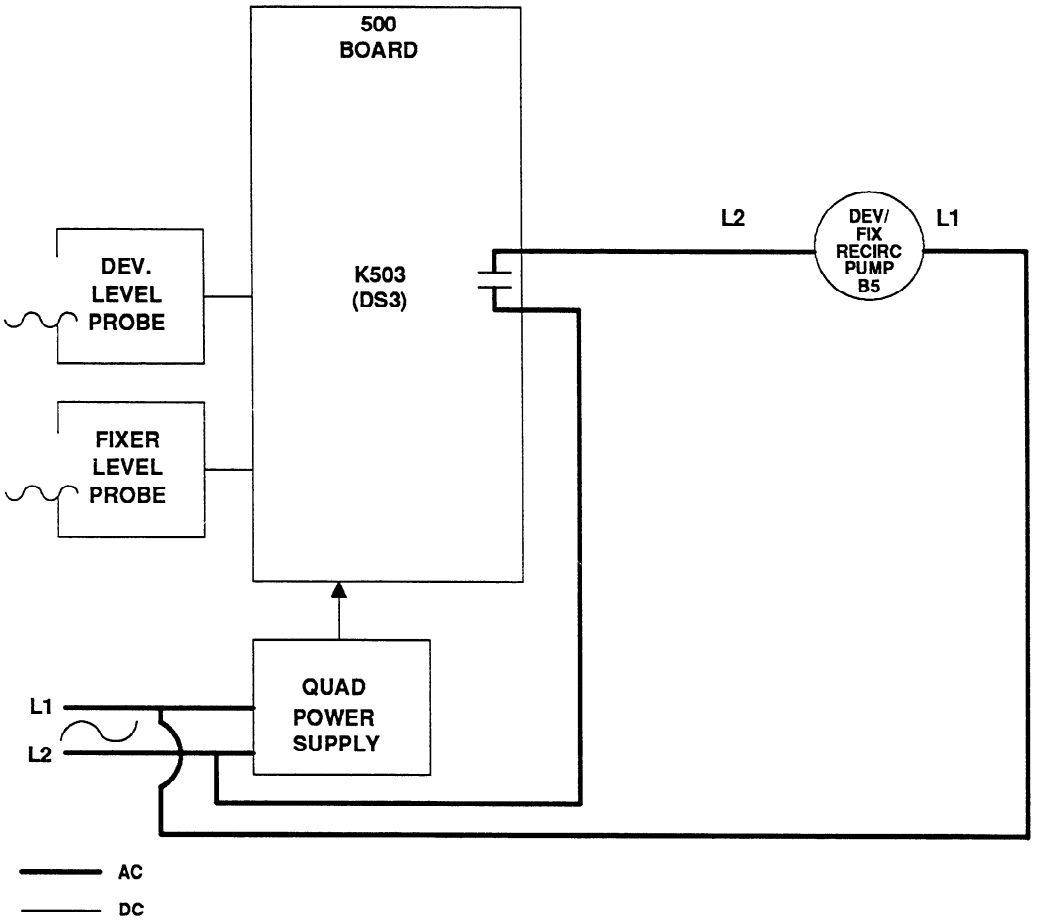
The processor only checks the solution levels during initialization (at power-up) and replenishment.

If the above conditions exist and power is applied to the processor, the contacts in the developer/fixer recirculation relay K503 (LED DS3) close. This provides power to the recirculation pump, causing it to energize.

NOTE

When an enable relay is energized, the corresponding LED on the 500 board will also energize.

BLOCK DIAGRAM
DEVELOPER/FIXER RECIRCULATION CONTROL



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Monitoring Developer Temperature

While the developer is recirculating, a thermistor in the thermowell monitors the temperature of the solution. The resistance of the thermistor changes inversely with the temperature of the solution. This data is sent to the microprocessor, which controls the heating and cooling systems. For more information about the control circuitry of the thermistor, see page 42.

The temperature is determined by performing an analog-to-digital (A/D) conversion on the resistance of the thermistor. This data is then converted to a temperature in °F by means of a software algorithm. The temperature is then compared to the setpoint to determine if heating or cooling is required.

Developer Heating System

The developer solution is heated to provide optimum conditions for processing film. A heater, located inside the thermowell, pulses at different duty cycles to maintain the optimum temperature. The microprocessor controls the duty cycle of the heater based upon the data received from the thermistor.

The heating of the developer is controlled by a proportional method, which operates in the following manner:

(1) The heater is turned on full until the temperature of the solution is 0.5°F below the setpoint.

(2) The heater operates on a duty cycle of 75% until the temperature of the solution is 0.3°F below the setpoint.

(3) The heater operates on a duty cycle of 50% until the temperature of the solution is 0.1°F below the setpoint.

(4) The heater operates on a duty cycle of 25% until the setpoint temperature is reached.

(5) When the setpoint temperature is reached, the developer heater shuts off.

Developer Cooling System

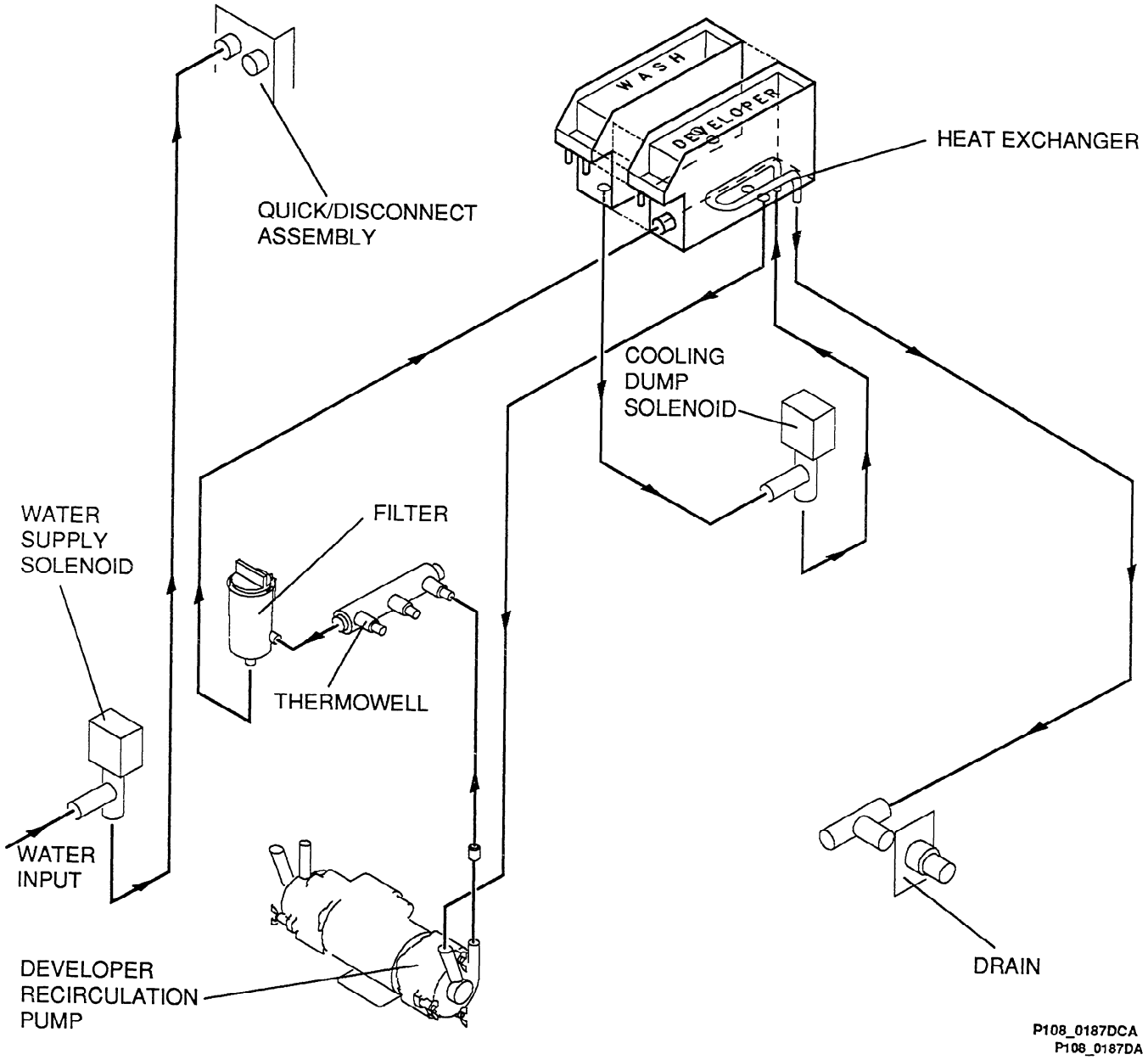
The temperature is read every ½ second. When the temperature of the developer is 0.3°F or higher than the setpoint for 5 consecutive readings, the cooling system is activated (assuming water supply exists). The cooling dump solenoid deenergizes and water from the wash tank is directed into a heat exchanger located at the bottom of the developer tank. The cooler water in the heat exchanger effectively cools the developer. As the water leaves the heat exchanger, it is drained from the processor.

The cooling cycle continues until the temperature is 0.1°F below the setpoint for one reading of the developer thermistor. The cooling dump solenoid then energizes, shutting off the water supply to the heat exchanger.

The cooling cycle will not activate unless the wash water solenoid is energized and the quick/disconnect assembly is connected, providing water supply to the wash tank.

Developer Temperature Display

The developer temperature displayed on the display panel is calculated by averaging 10 consecutive temperature readings. Therefore, it is updated approximately every 5 seconds.



Developer Heating and Cooling Systems

Temperature Control Errors

The developer heating and cooling systems are responsible for maintaining the developer at the current processing cycle temperature setpoints under all operating conditions. If the developer solution falls outside the tolerance zone, and the software cannot correct the temperature within a specified time limit, the processor will display an error message.

The developer solution should stabilize at the setpoint temperature within 20 minutes after start-up or a cycle change, and within 5 minutes during normal operation. If the rate of change for the developer temperature is not within the specifications, the processor will display one of the following error messages:

(1) **Unable to Determine Developer Temperature (ERR 034)**

If the thermistor is opened or shorted, or the temperature control A/D converter is not operating correctly, an ERR 034 will be displayed (if it is the highest priority). This error cannot be cleared unless the processor is deenergized and then energized again. For more information about this condition, see the thermistor control section on page 42.

(2) **Loss of Developer Heating Ability (ERR 037) and Loss of Developer Cooling Ability (ERR 038)**

The rate at which the developer solution is heated and cooled is checked. If the rate is not correct, the appropriate error code will be displayed (if this error is the highest priority). These errors are cleared when either the rate corrects itself or the setpoint temperature is reached.

The cooling rate is checked as long as cooling is needed. The heat rate is checked only when:

- the developer heater is on full
- the temperature of the solution is above 84°F
- the replenish pumps are not on

NOTE

- minimum heating rate = an increase of 2.0°F every 2 minutes
- minimum cooling rate = a decrease of 0.1°F every 3 minutes

Developer Temperature Control Circuit

Now let's examine the developer temperature control circuit. The diagram on the opposite page identifies the main components and their electrical requirements.

The developer and fixer tanks must be full before the heating or cooling circuits will activate. Once the developer and fixer level probes provide a path to ground, the microprocessor sends dc voltage to two relays; K503 and K504. These relays prevent the recirculation pump, the developer heater and the fixer heater from operating until the tanks are full. A dc voltage energizes relay K503 (LED DS3), allowing ac voltage to activate the recirculation pump. Relay K504 (LED DS4), which enables the heater circuit, also energizes. This relay sends ac voltage to the heater solid state relay U2, which applies ac voltage to the heater.

Now the microprocessor will react to the temperature input received from the developer thermistor.

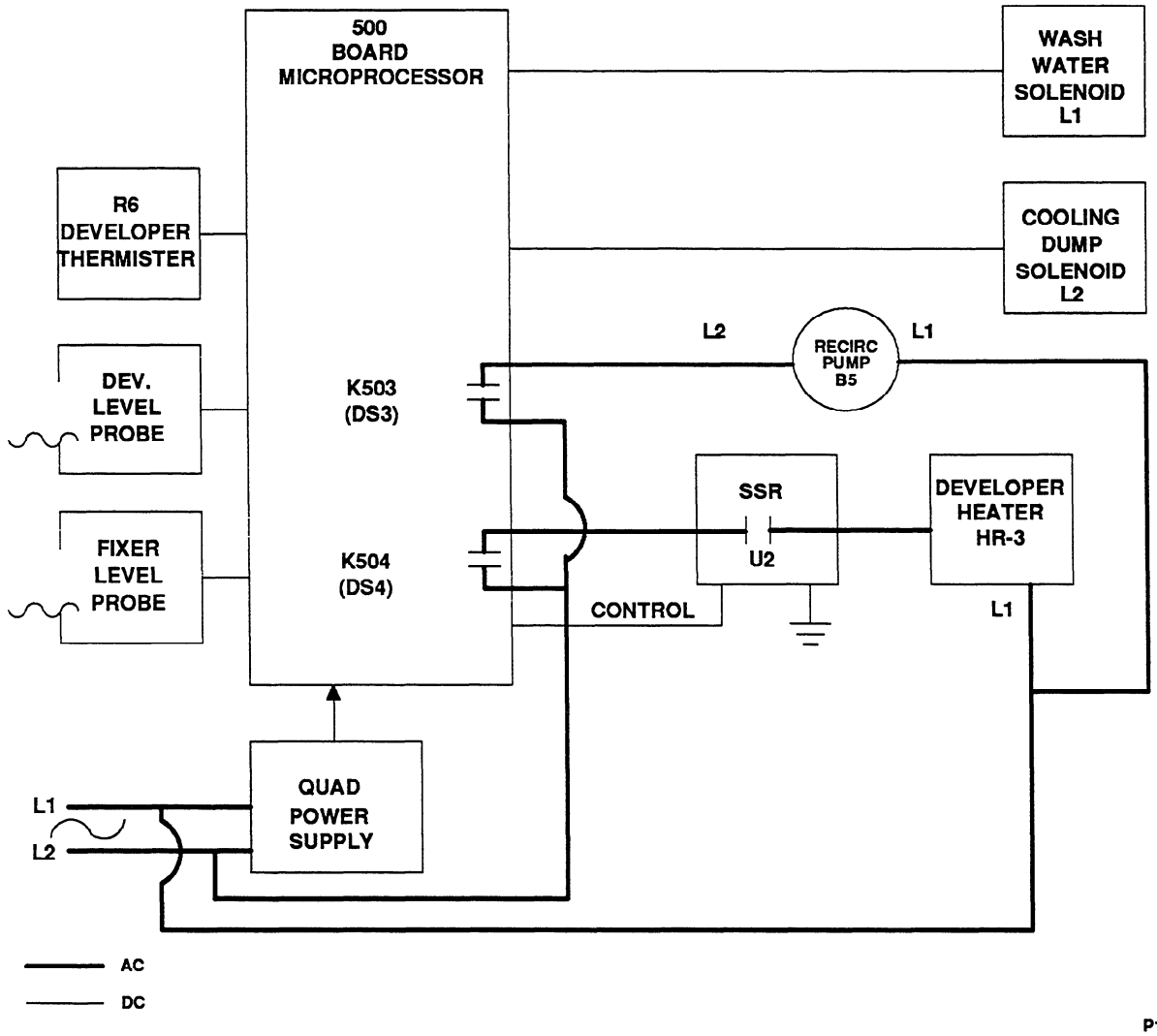
- **If the temperature is below the setpoint**, the microprocessor applies DC voltage to the developer heater solid state relay. When the relay energizes, the voltage activates the developer heater. The developer heater operates continually, but at different duty cycles, depending upon the detected temperature.

- **If the temperature is above the setpoint**, the microprocessor turns off the developer heater, activates the water supply solenoid (if it is not already energized) and deactivates the cooling dump solenoid. The cooling dump solenoid opens the path to the heat exchanger in the developer tank, allowing water to enter the heat exchanger and cool the developer.

NOTE

When an enable relay energizes, the corresponding LED on the 500 BOARD also energizes.

BLOCK DIAGRAM
DEVELOPER TEMPERATURE CONTROL



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Fixer Tank

Now that the film is developed, it leaves the developer tank and is transported into the fixer tank. This tank contains fixer solution, which stops the development of the visible image on the film. It also increases the permanency of the visible image. The fixer solution accomplishes this by removing unused silver halide crystals from the film.

The fixer tank is almost identical in operation to the developer tank. It is both filled and replenished automatically from an external container of fixer solution. For more information about the replenishment cycle, see page 36.

Fixer Recirculation

Like the developer, fixer is recirculated by a recirculation pump continuously through a thermowell where a thermistor monitors the temperature of the solution. The fixer recirculation pump is magnetically coupled with the same motor as the developer recirculation pump.

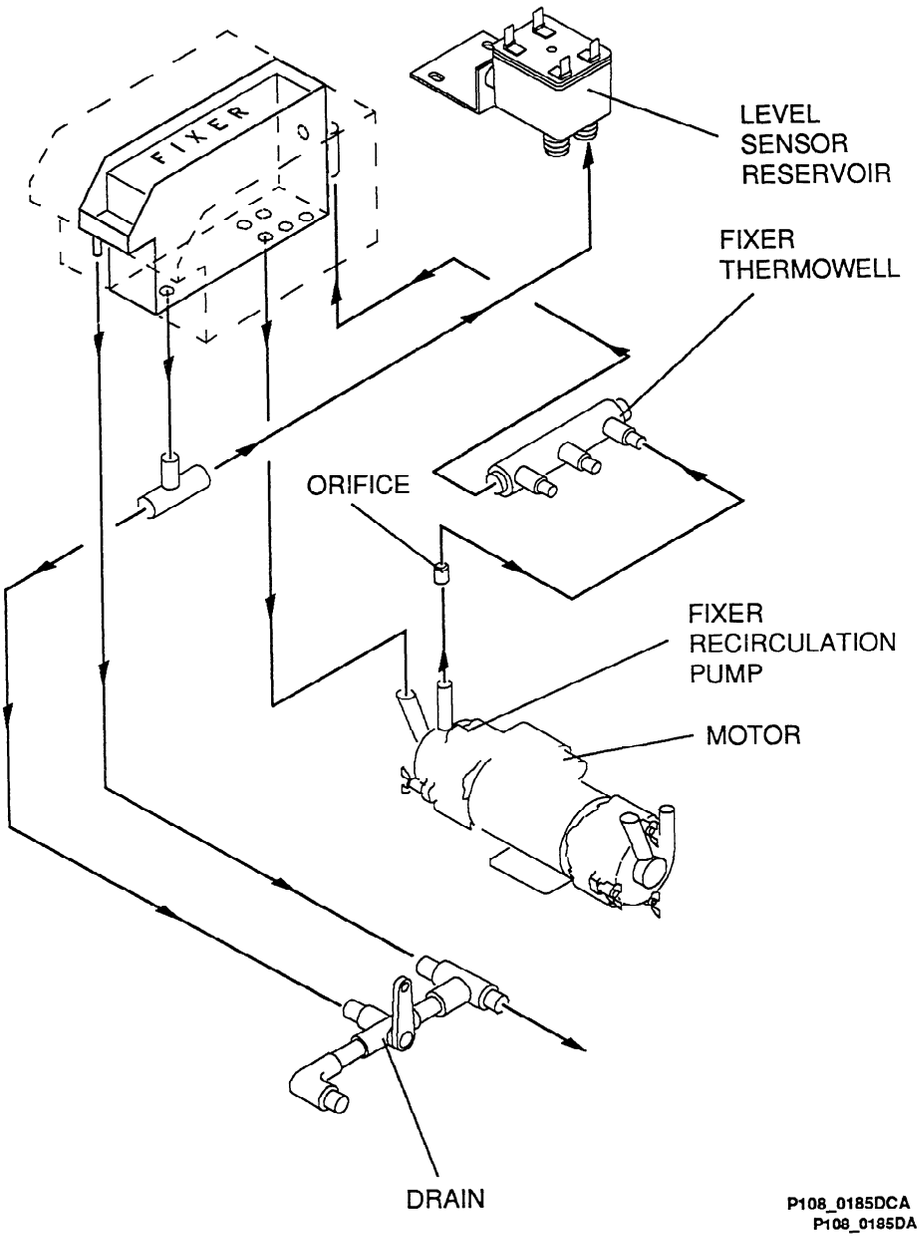
Recirculation takes place only when both the fixer and developer tanks are full. A full condition is detected by a sensor in the level sensing reservoir.

The fixer tank, like the developer tank, is connected to the reservoir by tubing. The level of fixer in the reservoir depends upon the solution level in the fixer tank. When the level is correct, the 2 fixer sensor probes are immersed in solution, providing a path to ground. The microprocessor, which monitors the resistance of the circuit, detects the lowered resistance and determines a correct solution level. When the level is not high enough to cover the probes, the circuit has a high resistance. The microprocessor detects the high resistance and determines a low level condition.

Fixer Level Detection

The fixer solution detect function is controlled by a multiplexer circuit. The fixer level sensor and the fixer thermistor channel are selected at the same time. The solution level input is read just before the temperature control, analog-to-digital (A/D) converter is read.

- If the level sensor is not immersed in fixer solution for 10 consecutive readings (approximately 5 seconds), the solution is considered low.
- If the level sensor is immersed in solution, the fixer solution is considered at the operating level.



Fixer Recirculation System

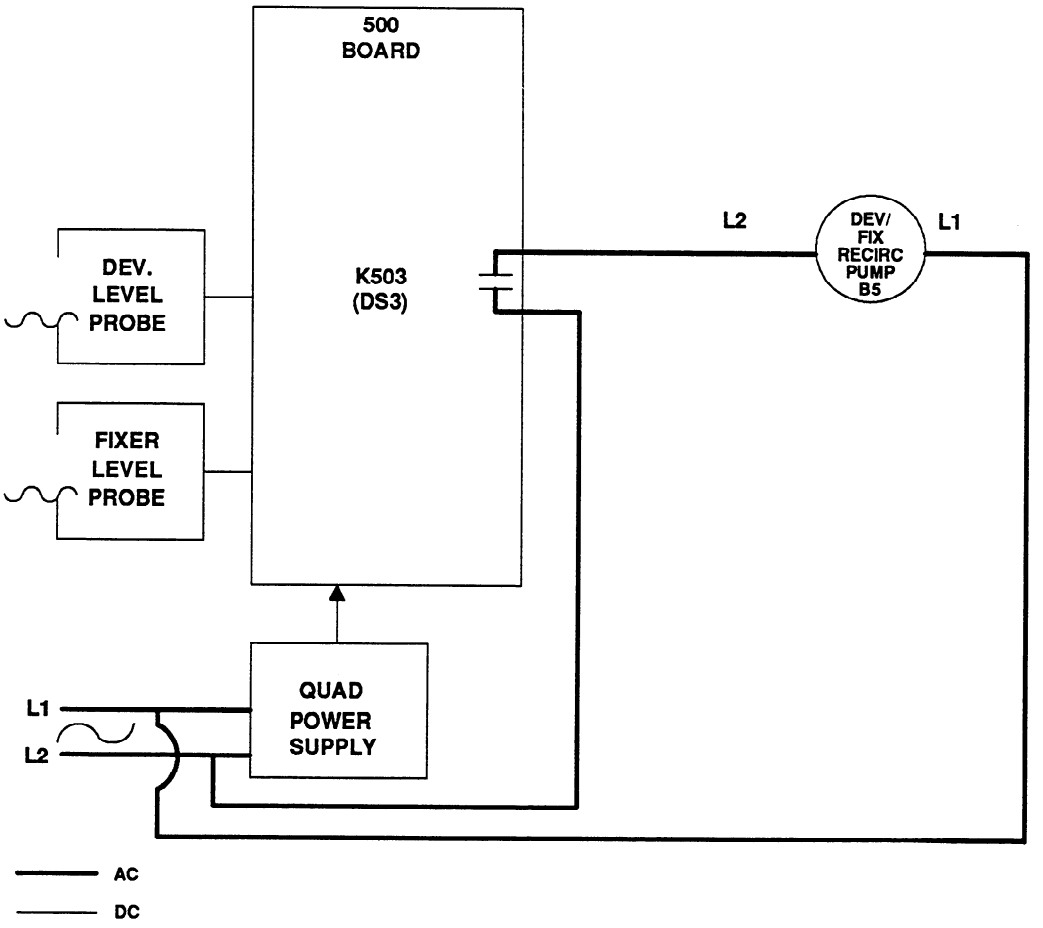
Fixer Recirculation Control Circuit

The electrical circuit for the fixer recirculation is similar to the developer recirculation circuit. Let's review the control circuit shown below.

Before recirculation will begin, the developer and fixer must be at the correct level in the tanks. This occurs when the developer and fixer level probes provide a path to ground.

If the solution levels are correct and power is applied to the processor, the microprocessor energizes the recirculation relay K503 (and LED DS3), causing its contacts to close. This provides power to the fixer recirculation pump, causing it to energize and recirculate the fixer.

BLOCK DIAGRAM
DEVELOPER/FIXER RECIRCULATION CONTROL



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Fixer Temperature Control

Monitoring Temperature

Now that the fixer solution is circulating, a heater in the thermowell heats the solution to increase its effectiveness. This is especially important to support the faster processing cycles. Like the developer thermowell, a thermistor in the fixer thermowell will monitor the temperature of the fixer solution. The fixer heater is either completely on or completely off. It's duty cycle is not regulated like the developer heater. For more information about the control circuitry of the thermistor, see page 42.

The temperature is determined by performing an analog-to-digital (A/D) conversion on the resistance of the thermistor. This data is then converted to a temperature in °F by means of a software algorithm. The temperature is then compared to the setpoint to determine if heating or cooling is required.

Heating System

The fixer, which operates more effectively at higher temperatures, does not have to be cooled. The fixer heater operates at full capacity when the fixer is below the setpoint. When the temperature is above the setpoint, the heater is turned off.

Like the developer, the fixer solution should stabilize at the setpoint temperature within 20 minutes after start-up or cycle change and within 5 minutes during normal operation. If the rate of change for the fixer temperature is not within specifications, the processor will display an ERR 039 error message.

Temperature Display

The fixer temperature can be displayed by pressing a key on the display panel. The displayed temperature is an average of the last 10 consecutive temperature readings.

Temperature Control Errors

The temperature control function checks for the following errors:

(1) **Loss of Fixer Heating Ability (ERR 039)**

The rate at which the fixer solution is heated is checked. The minimum acceptable heating rate is an increase of 2.0°F every 2 minutes. If the rate is not correct, an ERR 039 is displayed (if it is the highest priority). This error is cleared when either the rate corrects itself or the setpoint temperature is reached. The heat rate error is only checked when:

- the fixer heater is on full
- the temperature of the solution is above 84°F
- the replenish pumps are not on

(2) **Unable to Determine Fixer Temperature (ERR 035)**

If the thermistor is opened or shorted, or the temperature control A/D an ERR 035 will be displayed (if it is the highest priority). This error cannot be cleared unless the processor is deenergized and then energized again. For more information about this condition, see the thermistor control section on page 42.

Fixer Temperature Control Circuit

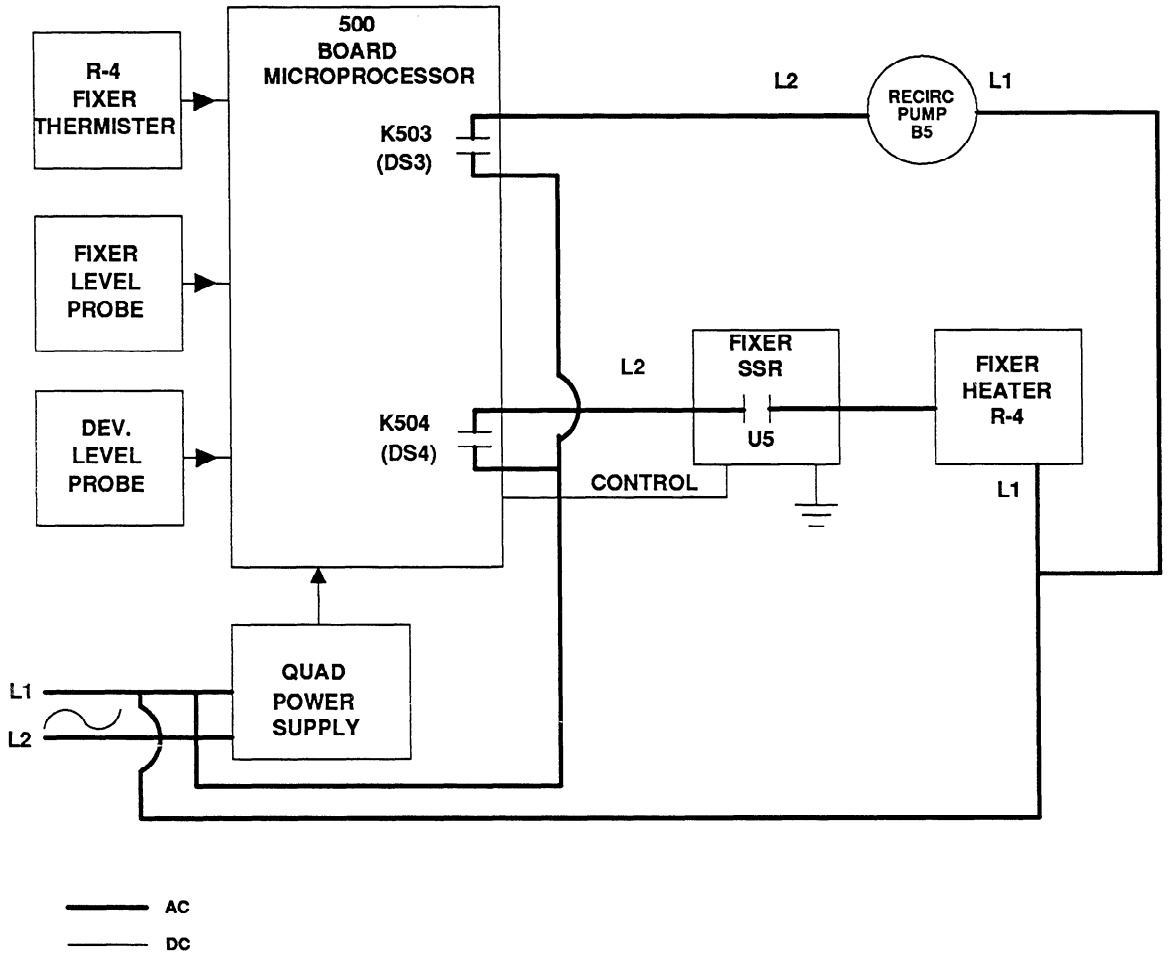
Now that you are familiar with the heating cycle of the fixer solution, let's examine the circuit that controls the heating operation. The circuit is illustrated on the next page. The fixer and developer temperature control circuits are similar, except the fixer does not include a cooling circuit.

The fixer and developer tanks must be filled before the heating circuit will activate. Once the fixer and developer level probes provide a path to ground, the microprocessor sends dc voltage to energize two relays; K503 and K504. When relay K503 (LED DS3) energizes, the AC voltage activates the fixer recirculation pump. Relay K504 (LED DS4), which enables the heater circuit, sends AC voltage to the solid state relay U5. Relay K504 is shared with the developer temperature control circuit.

Now the microprocessor applies DC voltage to the fixer heater solid state relay, which activates the fixer heater. The fixer heater is either on or off, depending upon the temperature detected by the thermistor.

Because fixer temperature control is not as critical as developer temperature control for consistent film quality, the fixer heater is not ramped like the developer heater.

BLOCK DIAGRAM
FIXER TEMPERATURE CONTROL



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Wash Tank

Now that the latent image has been developed and made permanent, the film leaves the fixer tank and enters the wash tank. The wash tank contains fresh water that removes all excess developer and fixer solutions from the film. This is necessary because residual chemistry will cause artifacts on the film during the drying process and reduce the permanency of the image.

Wash water is supplied through the customer's external water supply. The temperature of the water must be 4 - 32°C (40 - 90°F). The water temperature must remain at least 5° below the operating setpoint of the developer temperature. The water then passes through a 50-micron water line filter (supplied by the customer).

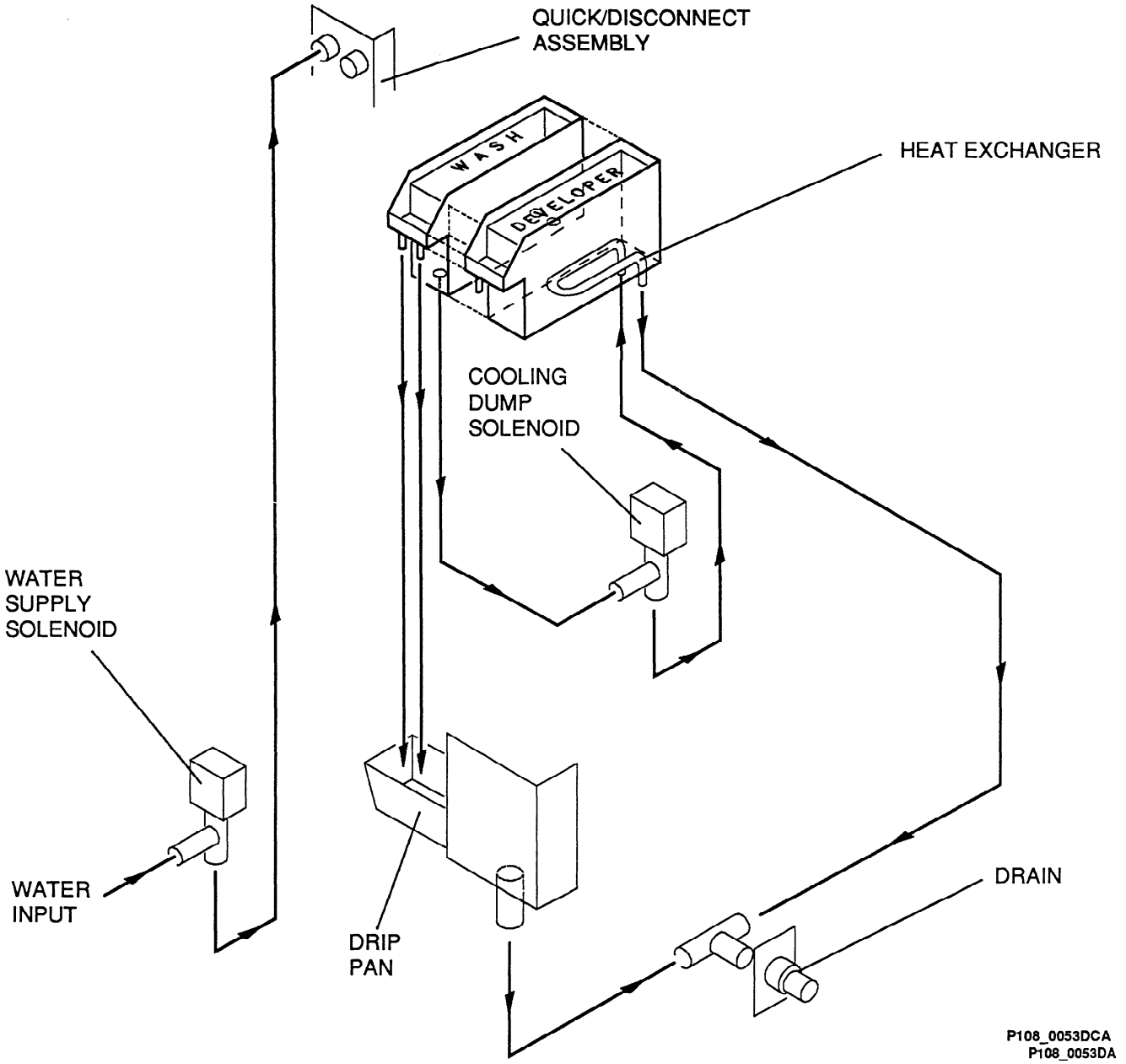
A hose connects the supply at the rear of the processor. A water supply solenoid, located behind the hose connection, controls the flow of water. The water supply solenoid:

- opens when film is detected by the film accumulator. This supplies water to the tank at a rate of 5.7 L (1.5 gal) per minute, ±10%. The water enters the tank through the wash/fixer crossover.
- closes 15 seconds **after** the film leaves the dryer, provided no additional films enter the processor.
- opens and closes to provide water to the heat exchanger to cool developer when necessary.

The water flows from the water supply solenoid, through the quick/disconnect assembly to the crossover assembly. If the connection at the quick/disconnect assembly is not correct, the water flow will stop and no water will enter the wash tank.

Any overflow in the wash tank falls into a drip pan. The water in the drip pan is then drained through a hose at the rear of the processor.

When the processor is turned off, the wash tank drains completely to minimize biological growth.



Water System

Wash Water Control Circuit

Now let's look at the wash water control circuit. You have already reviewed the circuit as part of the developer temperature control circuit.

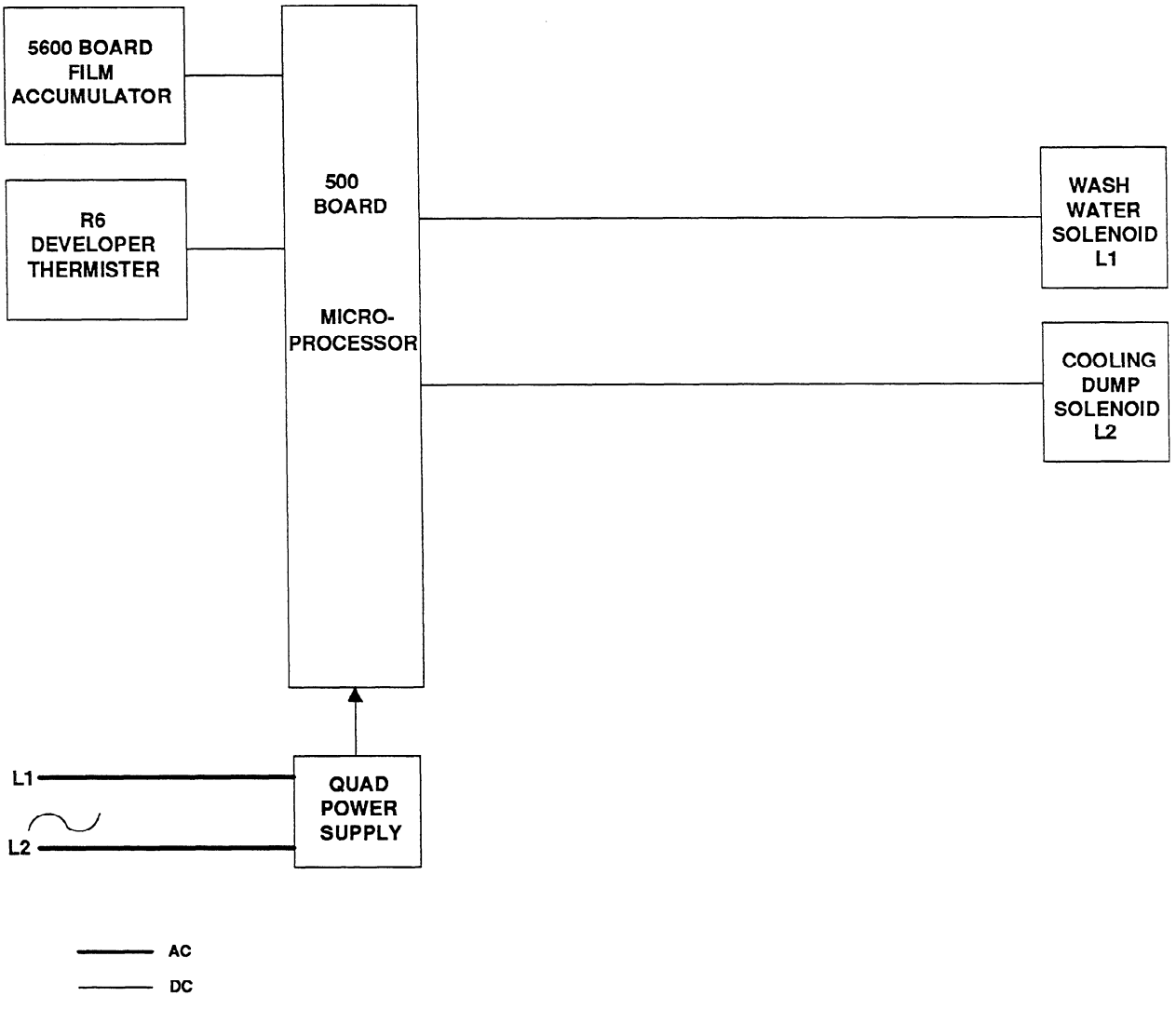
The circuit activates when film is detected at the film accumulator. The microprocessor then energizes the water supply solenoid, which allows water to flow into the wash tank. The solenoid remains energized as long as film is being processed. When the processor enters the standby mode (that is, when no film is present for processing), the microprocessor deenergizes the water supply solenoid and stops the water flow to the processor.

When the developer thermistor detects a developer temperature (0.3°F) higher than the setpoint, the microprocessor deenergizes the cooling dump solenoid. The deenergized solenoid opens the path to the heat exchanger, allowing water from the wash tank to enter the heat exchanger at the bottom of the developer tank. The circulation of developer around the heat exchanger will cool the developer.

If the developer must be cooled when the processor is in the standby mode, the water supply solenoid will also energize. This prevents the heat exchanger from lowering the water level in the wash tank.

Once the developer thermistor detects a temperature below the setpoint, the microprocessor energizes the cooling dump solenoid, which stops the water flow through the heat exchanger. If the processor is in the standby mode, the water supply solenoid will deenergize also. If the processor is in the operating mode, however, the water supply solenoid remains energized.

BLOCK DIAGRAM
WATER CONTROL



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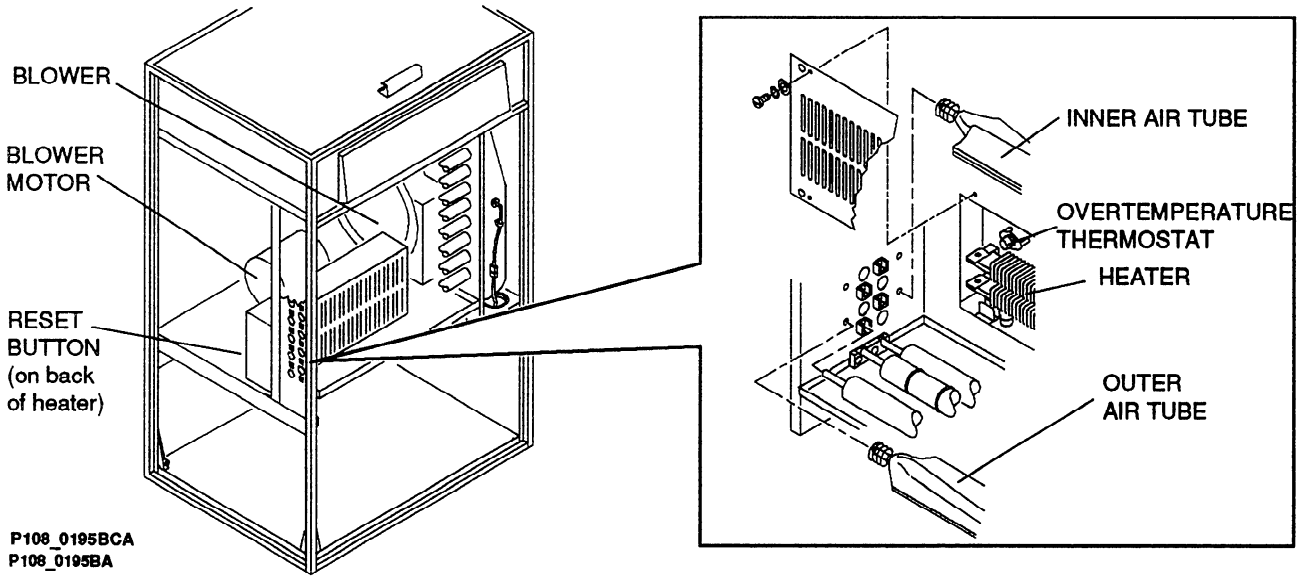
Dryer

As the film leaves the wash tank, it passes through the squeegee crossover. This crossover spreads any remaining droplets of water across the film surface to encourage faster drying time and eliminate water spots.

The film then enters the vertical transport of the dryer, where inner and outer air tubes circulate hot air across the film. The air tubes are located on both sides of the dryer. This means that both sides of the film are dried at the same time.

The dryer blower motor provides the air supply for the air tubes. The blower energizes when film is detected by the film accumulator. A dryer heater heats the air to a temperature within 38 - 65.5°C (90 - 155°F). The temperature in the dryer is sensed by a thermistor, and can be adjusted in 5° increments through the display panel. For more information about the operation of the thermistor, see page 42.

If the temperature becomes excessive, an overtemperature thermostat will shut off the dryer heater. The thermostat must be manually reset before the heater can operate again.



Dryer Temperature Control

The temperature of the air is determined by converting the resistance of the thermistor into °F. This value is then compared to the setpoint.

If the temperature is below the setpoint, the dryer blower and dryer heater are turned on. The blower activates first, with the heater following 2 seconds later (this prevents damage to the heater). The heater always operates at full capacity. When the temperature is above the setpoint, the dryer heater is turned off.

The dryer temperature is not displayed on the processor. The dryer temperature setpoint, however, is displayed on the display panel.

Temperature Control Errors

The temperature control function checks for the following errors:

(1) **Inoperative Dryer Error (ERR 040)**

The rate at which the air in the dryer is heated is checked. The minimum acceptable heating rate is an increase of 0.5°F every 2 minutes. If the rate is not correct, the error ERR 40 will be displayed (if it is the highest priority error).

The heat rate error is only checked when:

- the dryer heater is operating
- film is not present in the processor
- after initialization is completed at power-up

(2) **Unable to Determine Dryer Temperature (ERR 036)**

If the thermistor is opened or shorted, or the temperature control A/D converter is not operating correctly, an ERR 036 will be displayed (if it is the highest priority error). This error cannot be cleared unless the processor is deenergized and then energized again. For more information about this condition, see the thermistor control section on page 42.

(3) **Dryer Overtemp Data Error (ERR 002)**

If the dryer temperature exceeds the maximum value of the A/D converter (approximately 167°F), an overtemperature condition exists. The error ERR 002 will be displayed and the processor will shutdown after the last film exits.

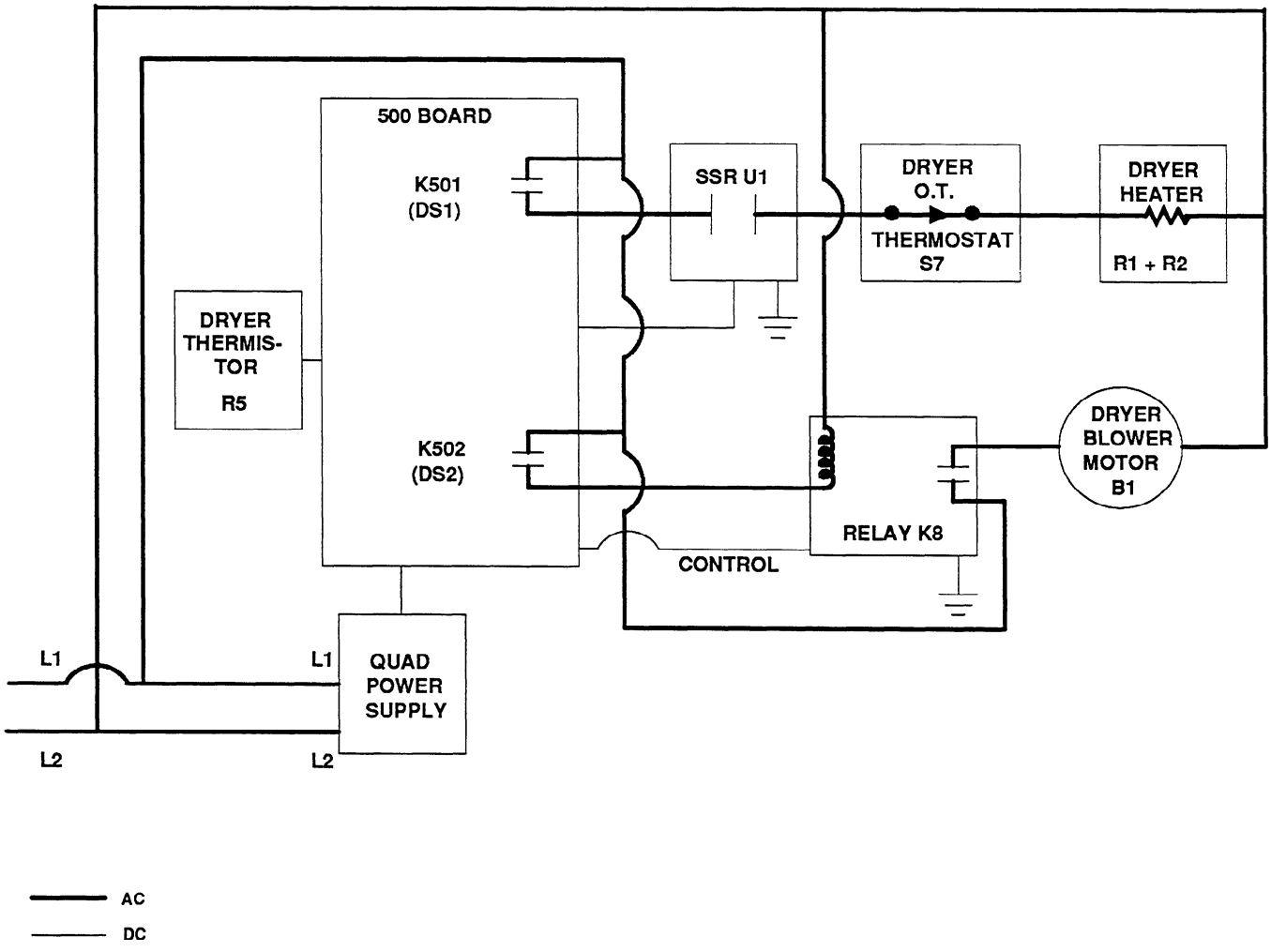
Dryer Temperature Control Circuit

Now that you are familiar with the dryer components, let's review the electrical circuit that controls them.

When film is detected at the film accumulator, the microprocessor sends DC voltage to the dryer blower relay K502 (LED DS2). This is an enable relay, which controls the AC power to relay K8. The K8 contacts close, allowing AC voltage to energize the dryer blower motor.

Now the microprocessor begins monitoring the thermistor. When the air temperature is low, the microprocessor sends a DC signal to the dryer heater solid state relay U1. The relay closes, and AC voltage is applied to the overtemperature thermostat and the dryer heater. If the thermostat detects an overtemperature condition in the plenum, the thermostat opens, and AC voltage to the dryer heater is cut off.

BLOCK DIAGRAM
DRYER TEMPERATURE CONTROL



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Standby Mode

If no new film enters the processor, the processor will enter the standby mode approximately 15 seconds after the last film has exited. Because the processor does not have an exit detector, the software determines when the film has exited, based upon the transport speed and length of the film path.

There are two types of standby mode, Continuous and Interval. The customer selects the desired standby mode through the display panel.

The following events occur when the processor enters the standby mode:

(1) The water supply, unless needed for developer cooling, is turned off.

(2) The developer temperature is maintained at the setpoint.

(3) The dryer temperature is maintained at the setpoint. It will cycle on and off every 4 minutes, or 45 seconds, depending upon the selected transport speed. During each cycle, the blower activates and the dryer temperature is read. If the temperature is below the setpoint, the heater and blower are turned on until the temperature reaches the setpoint.

- 4-minute cycle: 0 - 69 in./min
- 45-second cycle: 70 - 135 in./min

(4) The drive motor operation changes, depending upon the type of standby mode selected by the user through the display panel. See the following descriptions.

Continuous Standby Mode

The drive motor remains energized, but operates at a very low speed after the film has exited. (With the current specifications, the low speed is 34 inches per minute.)

Interval Standby Mode

The drive motor turns off and on at established intervals to allow wetting of the rollers. With the current specifications, this means the motor will repeatedly turn off for 8 minutes, and on for 90 seconds. At the completion of the cycle, the following occurs:

(1) The drive motor turns on and runs at the set speed.

(2) The supply water turns on.

(3) The 90-second timer begins. When the 90-second timer expires:

a. the drive motor turns off

b. the water shuts off

c. the 8-minute timer begins to initiate the cycle again

The processor will automatically exit standby mode and enter the operating mode when film is detected by the film accumulator.

SECTION 5
Replenishment

While film is being processed, the chemicals in the developer and fixer solutions are absorbed into the film. This results in a depletion of chemicals in the tank. New chemicals, therefore, must be added periodically to maintain an effective level of chemical activity.

In this processor, new developer and fixer solutions are replenished automatically to maintain the correct chemical activity and level of solutions in each tank. Two pumps, one for developer and one for fixer, pump new solutions from external containers that are connected to the processor. A spring in the output side of each replenishment pump equalizes the replenishment flow between the tanks and the calibration cylinders. This spring compensates for head height differences between the tanks and the pumps.

The replenishment pumps are set, through a switch at the rear of the pumps, to either 50 or 60 Hz power. The pumps must be set at the correct power configuration (at the installation site) to ensure correct operation of the pumps.

The new solutions are pumped directly into the developer and fixer tanks where they enter the recirculation system.

The replenishment pumps can be disabled to allow maintenance of the processor. There are 2 methods of disabling the replenishment pumps:

(1) **Removing the processor top cover**

This disables the replenishment pumps and displays the error code ERR 128.

(2) **Activating the disabling function through the soft keys**

This disables the replenishment pumps also. An error code (ERR 130) will be displayed when the pumps are disabled using this function.

Replenishment Modes

The processor offers two types of replenishment, which can be selected by the user through the display panel. Both replenishment modes use the film area detected by the film accumulator to calculate replenishment needs. Let's look at the two replenishment modes and how they operate:

(1) **Auto Replenishment Mode**

This is the standard replenishment mode of the processor. In this mode, the replenishment cycle is activated each time approximately 0.15 sq meters (238 sq in.) of film has been detected. This is equivalent to one 35 x 43 cm (14 x 17 in.) sheet of film.

The amount of replenishment solution, however, varies depending upon the normal film usage for the processor. The microprocessor will automatically calculate the amount of replenishment solutions required by the usage level. See the table below for usage levels.

Replenishment Calculation:

The on-time for the pumps is calculated by multiplying the *on-time percentage* (the number of films processed every 30 minutes) times the *replenish volume* stored in memory. This result is divided by the *replenish flow rate* that is stored in memory. The variables are defined below:

- On-Time Percentage:

  The on-time percentage is calculated by the number of films processed every 30 minutes.

- Replenish Volume:

  The replenish volume stored in memory is the volume needed for the high film usage rate.

(2) **Flooded Replenishment Mode**

This mode activates the replenishment cycle when approximately 1.5 sq meters (238 sq in.) of film has been processed, and at 5 minute intervals. The amount of solution added to the tanks is predetermined in the software, and can be adjusted by the user within a certain range. The flooded replenishment mode is intended for use in low volume applications where 25 or less 14 x 17 in. films are processed per day.

Replenishment Calculation:

- The amount of solutions added to the tanks is determined by the value stored in memory.
- The on-time of the pumps is calculated by dividing the *flooded replenishment volume* by the *replenishment pump flow rate*.

Table 1 Auto Replenishment Mode: Replenishment Calculation

Usage Level	Film Count per 30 Minutes	On-Time Percentage
low	1 - 2	1.67 multiplier for developer 1.41 multiplier for fixer
medium	3 - 4	1.33 multiplier for developer 1.18 multiplier for fixer
high	5 or more	1.00 multiplier for developer and fixer

Filling the Developer and Fixer Tanks

Solutions are also added to fill the tanks when necessary. There are 2 filling procedures, depending upon the situation:

(1) **Topping Off the Tanks**

This method is used when the processor is first powered up and a low solution level is detected during the first 4 minutes. The corresponding replenishment pump is energized and solution is added to the tank. If the solution level is not correct within 2 minutes, a tank fill error occurs.

The tanks will also be filled if a low solution level is detected during the replenishment cycle. After the tank is filled, the replenishment volume will be added. This causes a slight overflow of solution for one replenishment cycle.

(2) **Tank-Fill Mode**

This method is used to fill an empty tank, which is usually necessary at processor installation or after periodic maintenance has been performed.

The tank-fill operation is activated through the display panel. When it is selected, the heaters, blower and drive motor are disabled, the wash water is turned on and the appropriate replenishment pump activates (unless it has been disabled). An error code (ERR 129) is displayed while the tank-fill operation is in progress.

The solution levels are checked constantly during the tank-fill operation. When the level sensor detects a correct solution level, the replenishment pump deenergizes, the error code ERR 129 is removed and the heaters, blower and drive motor are enabled. If both tanks are not filled within 10 minutes, the pumps will deenergize and a tank fill error will be displayed.

Replenishment Errors

The replenishment control checks for the following error:

Developer Tank Fill Replenishment Error (ERR 032) and Fixer Tank Fill Replenishment Error (ERR 033)

These errors occur when the developer and fixer solutions do not reach the correct level within the allowed time limit (2 minutes when topping off the tanks, and 10 minutes during tank-fill). If a developer tank fill error occurs, ERR 032 will be displayed (if it is the highest priority error). If a fixer tank fill error occurs, ERR 033 will be displayed (if it is the highest priority error).

Calibration

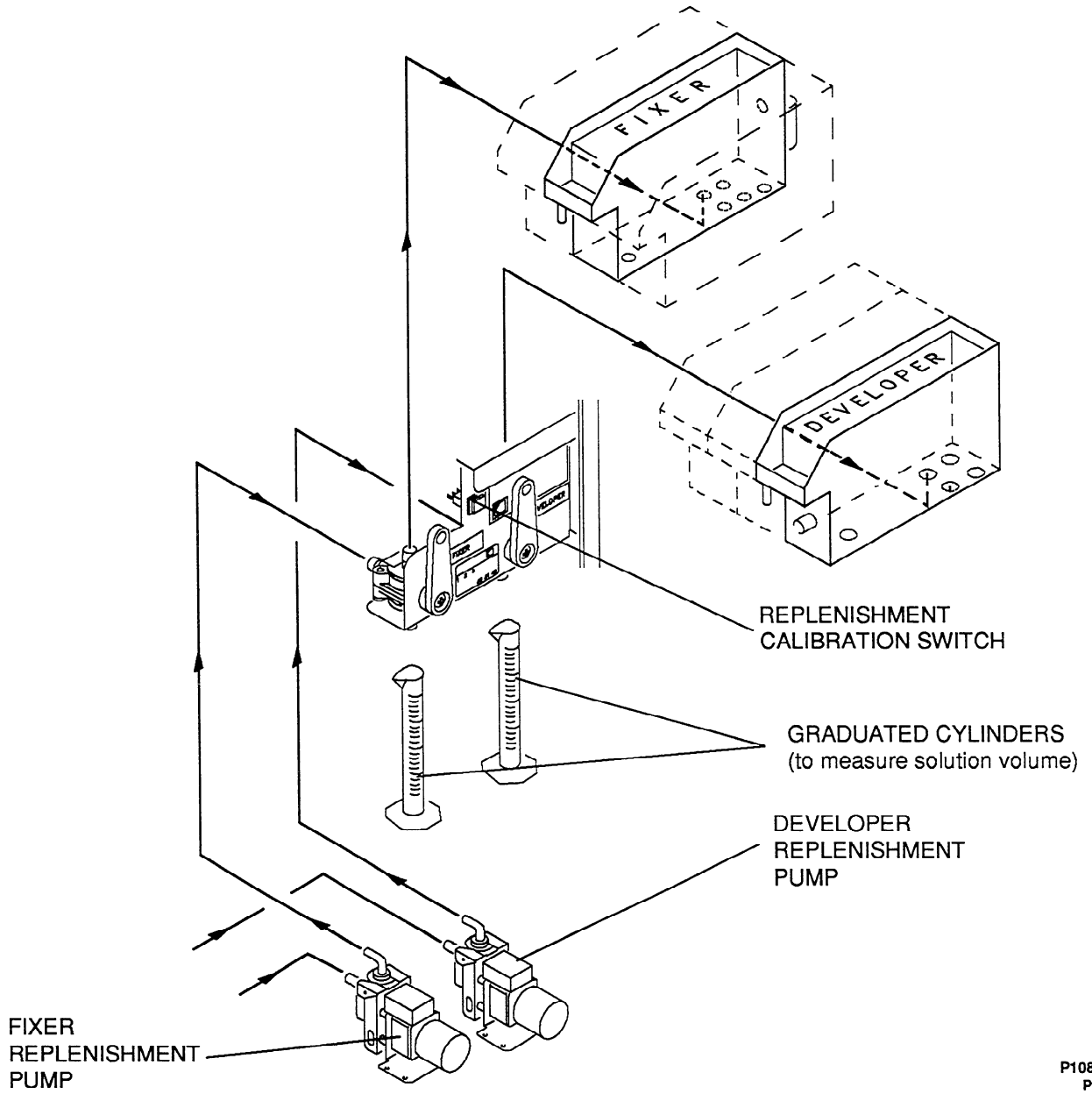
The flow of the pumps is calibrated by the microprocessor. The user enables this function through the display panel. The user must then press and release the replenishment calibration switch to activate the selected replenishment pump.

Now the user measures the volume of solution and compares it to the amount of solution the processor said it would output. This is displayed on the display panel. If they are the same, then the replenishment pump is calibrated correctly. If they are different, the user enters the amount of solution output by the pump into the software via the display panel. The software then recalculates the actual flow rate of the pump.

NOTE

The volume measured during the calibration procedure is not the same as the replenishment volume added to the tank for a 35 x 43 cm (14 x 17 in) film.

The replenishment calibration switch can be activated only when the user has selected the calibration function through the display panel. The switch is located internally and is intended for use by the authorized operators or service personnel only.



Developer and Fixer Calibration

Replenishment Control Circuit

We have mentioned several components and many variables that activate the replenishment system. The control circuit on the opposite page includes all these components. Like many other functions in the processor, the cover interlock switch must be actuated to enable the replenishment circuit.

After the interlock switch is actuated, one of the following 3 inputs will activate the replenishment circuit:

(1) **Detector Switches and Film Accumulator**

When film is present at the film accumulator **and** one or both detector switches are actuated, the 5600 circuit board begins counting undetected sensor pulses generated by the film accumulator. When 1.54 sq meters (238 sq in.) of film has been detected, the microprocessor activates the replenishment circuit.

(2) **300 Circuit Board**

The 300 circuit board signals the microprocessor when the auto-replenishment mode, flooded replenishment mode, tank-fill mode or calibration mode has been selected by the user. The microprocessor then activates the replenishment circuit when appropriate.

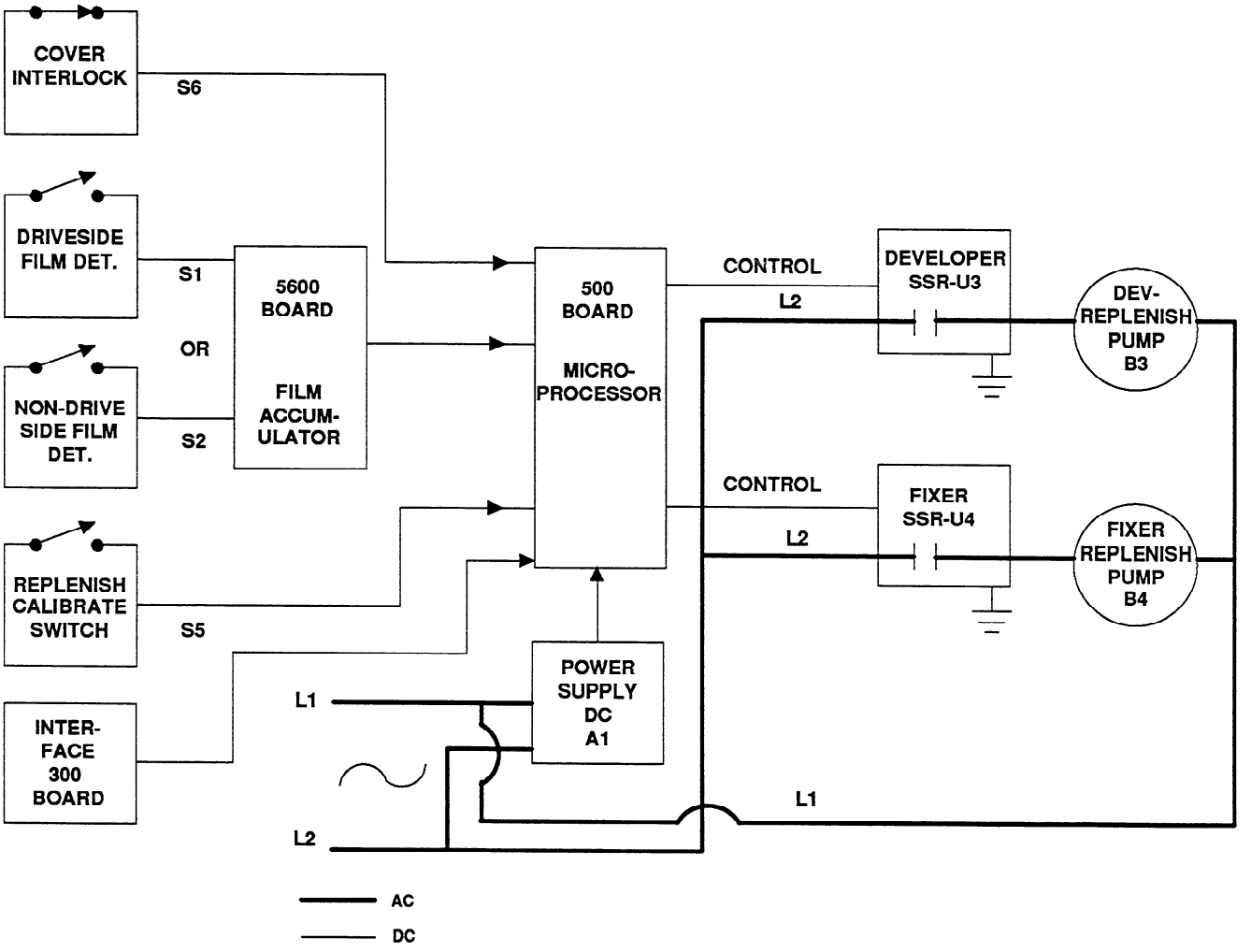
(3) **Replenishment Calibration Switch**

If the calibration mode has been selected (through the 300 circuit board) and the replenishment calibration switch is actuated, the microprocessor activates the replenishment circuit.

To activate the replenishment circuit, the microprocessor sends DC voltage to the developer and fixer solid state relays U3 and U4. The relays energize, and AC voltage is supplied to the developer and fixer replenish pumps. The pumps activate and the replenishment begins.

When the microprocessor determines that the appropriate amount of solution has been replenished, it removes the DC voltage to the solid state relays. The contacts open, and the AC power is removed.

BLOCK DIAGRAM
DEVELOPER/FIXER REPLENISHMENT CONTROL



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SECTION 6
Thermistors

The developer, fixer and dryer thermistors are controlled by multiplexer circuits and an analog-to-digital (A/D) converter. The multiplexer circuits set the channel and voltage range for the A/D converter.

Thermistor Error Detection

The processor checks for 3 different errors with the thermistors; wrong A/D temperature conversions, an opened thermistor and a shorted thermistors.

The temperature conversions are monitored through a precision resistor, which is read approximately every ½ second to verify the accuracy of the A/D conversion. If the value of this resistor is not correct for 5 consecutive readings, the A/D is considered inoperative.

An opened or shorted thermistor is determined by reading the internal A/D converter in the microprocessor. This A/D converter is read at the same time that the temperature control A/D converter data is read for the developer, fix and dryer channels. If the readings on the internal A/D fall outside of the allowed range for 5 consecutive readings, the thermistor is considered inoperative and an error is displayed.

These checks are not performed until 3 minutes after power-up. This delay prevents open thermistor errors due to cold solution temperatures or a cold room ambient.

SECTION 7
Displays and Control

Display Panel (300 Circuit Board)

The display panel, located on the front of the processor, allows the operator to select operating modes, change some parameters, and monitor the status of the processor.

The display panel is separated into the following areas:

Processor Status

This area includes 3 backlit messages that indicate the operating status of the processor.

- "Ready" Message:

  This message energizes when the processor is ready to accept film.

- "Wait" Message:

  This message energizes when the processor has not reached its optimum operating conditions.

- "Service" Message:

  This message energizes when the processor has an error that the operator cannot repair.

Menu Display and Soft Keys

This section displays menus indicating the operator selectable items. The operator uses 5 soft keys to select the desired items. The function of the soft keys changes according to the menu that is displayed. The contrast of the display can also be changed using the soft keys.

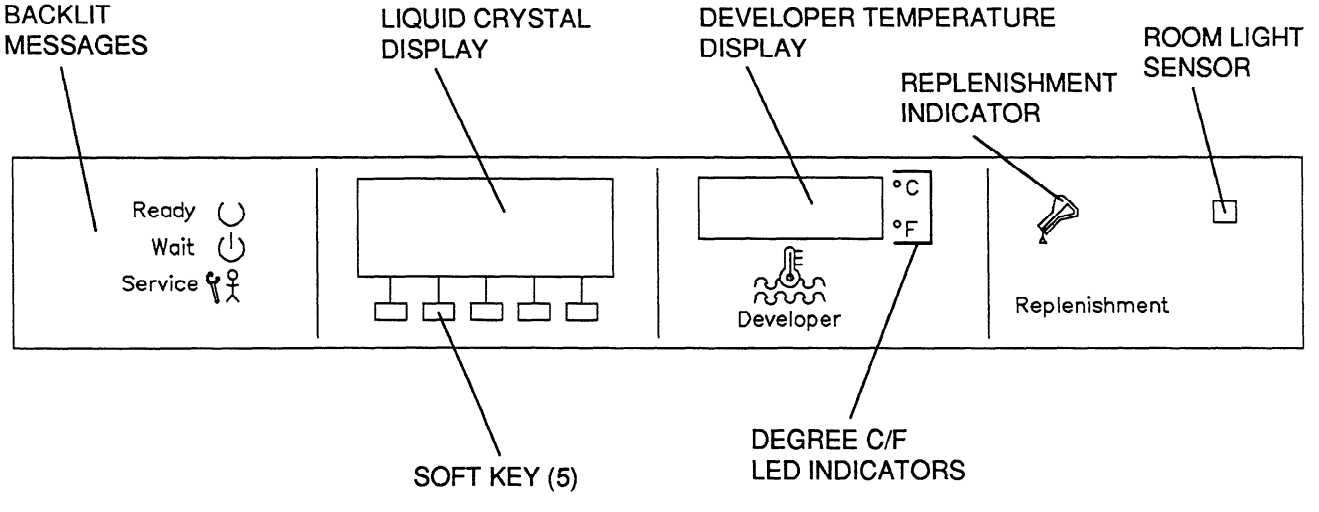
An access code is required to change setup information preset at the factory, and to change to or from the K/RA cycle. Other items do not require the access code.

Developer Temperature Display

This area displays the current developer temperature in either °C or °F.

Replenishment Indicator and Room Light Sensor

The replenishment indicator energizes when both replenishment pumps are activated. The room light sensor changes the illumination of the display panel according to the amount of available light in the room. If the available light falls below a specified limit, the room light sensor disables the backlighting and other indicators, and the software will not respond to any soft key selections. This prevents accidental changes of cycle or dryer settings in a dark environment.



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Control Panel (200 Circuit Board)

The control panel provides an electrical interface for the processor. It includes the following items:

Main Circuit Breaker CB1

This circuit breaker disconnects the main power source from the processor.

Electrical Interface Jack

This jack is used by some accessories to send a command that takes the processor out of the standby mode.

Processor Interface Connector (PIC)

This connector provides both individual status lines and an RS-232 serial data link. The serial link allows communications between the processor and a laptop or personal computer for the purpose of advanced diagnostics and updating processor software. The individual status lines include:

- indicate when the processor is powered on
- indicate when developer solution is at its operating temperature
- indicate when processor is ready to accept film
- cause the processor to exit standby mode.

Safelight/Accessory Receptacle

The receptacle provides power for safelights or other accessories. When used, the required mode must be selected through the display panel.

- **Safelight Mode**

  In the safelight mode, power to the receptacle is turned off when film is detected by the film accumulator. Power is turned on at the receptacle after the trailing edge alarm sounds.

- **Accessory Mode**

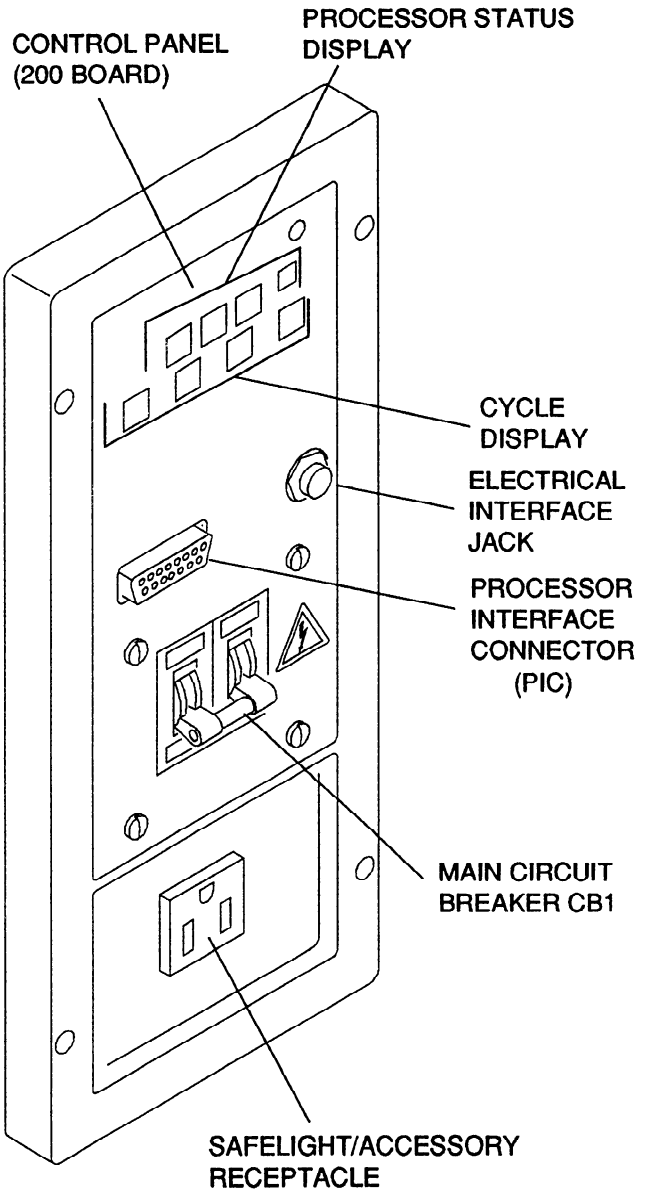
  In the accessory mode, power is applied to the receptacle continuously while the processor is turned on.

Processor Status Display

This area displays 3 messages indicating the operating status of the processor; "Ready", "Service" and "Wait". These messages are the same as those that appear on the display panel. See page 43 for an explanation of the messages.

Cycle Display

This area displays the selected processing cycle.



P108_0160CCA
P108_0160CA

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SECTION 8
Power Distribution and Control

AC Distribution

The processor runs on single-phase or 3-phase 200 - 240 V ac. The Site Specifications provides a complete list of all the various power configurations for which this machine can be adapted.

The processor uses AC power to operate all motors, except the drive motor which uses 24 V dc. AC power also supplies the quad power supply, which converts the power into 4 DC voltages.

When the power enters the processor, it first enters the main circuit breaker. From there it is directed to a transformer.

The transformer increases or decreases the incoming voltage and distributes the power into load-A, and, depending upon the service, load-B, load-C and load-D. Each load passes through an EMI filter located inside the transformer box. The circuit, illustrated on the opposite page, is described in more detail below.

- **Load A**

  Load A supplies power to the dryer blower motor, the exhaust fan motor, developer heater, developer and fixer replenishment pumps and the recirculation pump motor. It also supplies power to the interface transformer, which drops the voltage to 16 V ac. The 16 V ac is used at the electrical interface jack.

  The circuits for the dryer blower motor, the developer heater and the recirculation pump motor include an enable relay. These relays remain opened until the level sensors detect correct levels of developer and fixer solutions.

  NOTE

  On some early machines, the developer and fixer replenishment pumps are supplied through load C.

- **Load B**

  Load B supplies the power for the dryer heater. The circuit includes the manually reset overtemperature thermostat. If the thermostat detects an overtemperature condition, the thermostat opens. The solid state relay SSR1, which controls the power to the heater, deenergizes the heater. This circuit also includes an enable relay K501. This relay opens the heater circuit if an error condition exists (e.g., when the temperature cannot be controlled over a specific time period) and no air flow is supplied through the plenum.

- **Load C**

  Load C supplies power to the fixer heater and the quad power supply. The quad power supply converts the incoming voltage into +5, +12, -12 and +24 V dc. The DC power is sent to the 500 circuit board and other output devices in the processor. See page 49 for a description of the DC power distribution.

- **Load D**

  Load D supplies power to the safelight receptacle. This circuit includes relay K505 which controls the operation of the safelight receptacle.

TRANSFORMER CONNECTIONS SHOWN ARE FOR 120/208 3 PHASE 4 WIRE SERVICE WITH EARTH GROUND SEE TRANSFORMER CONNECTION DIAGRAM FOR OTHER SERVICES.

GND E1

L1 TB1-4 CB1 35 AMP TB1-1 TB2-6 TB2-3

L2 TB1-2 TB2-12

L3 TB1-3 TB2-2

TB2-7 H1 TB2-8 H2 TB2-9 H3 H5 H4 TB2-13 TB2-10

TB2-14 X1 TB2-16 X2 TB2-15 X3 TB2-17 X4

TB2-1 TB2-4

LOAD-D FL4 5A

F3 2 AMP

P/J40-10 P/J40-9 P/J2-10 P/J2-9 P/J502-18 P/J502-16 K505 PWB-500 P/J502-17 P/J502-15 P/J2-12 P/J2-11 P/J40-12 P/J40-11

J1 SAFELIGHT RECEPTACLE E9 E2

TB2-5 TB2-18 CB2 10A LOAD-A FL1 20A P/J40-2 P/J40-1 P/J2-2 P/J2-1

TB4-6 TB4-7 TB4-2 TB4-3

DRYER BLOWER RELAY K6 DRYER BLOWER MOTOR B1 P/J5-2 P/J5-1 P/J5-3 E6 TB4-4 K502 P/J502-6 P/J502-7

EXHAUST FAN MOTOR B2 P/J43-2 P/J43-3 P/J43-1 P/J3-2 P/J3-5 E6

DEVELOPER HEATER SSR U2 R3 1000W INT O.T. P/J8-5 P/J8-3 P/J8-4 E7 K504 P/J502-11 P/J502-12

RECIRC PUMP MOTOR B5 P/J7-1 P/J7-2 P/J7-4 E7 K503 P/J502-9 P/J502-10

INTERFACE XFMR T2 F1 .250 A

J7 J8 J9 P/J9-3 P/J9-2 P/J9-1 16VAC 32VAC TO PWB 200 CONTROL PANEL

TB2-20 TB2-19 CB3 15A LOAD-B FL2 20A

P/J2-7 P/J40-7 TB3-3 P/J2-8 P/J40-8 TB4-8

P/J40-6 P/J2-6 TB3-1 P/J40-5 P/J2-5

SSR U1 P/J4-6 P/J4-7 TB6-3 O.T. STAT S7 MANUAL RESET R1 155Ω W R2 155Ω W TB6-1 TB4-9 P/J4-1 P/J4-2 K501 P/J502-3 P/J502-2

SSR U3 P/J3-3 P/J37-2 60HZ 50HZ B3 P/J37-1 P/J37-3 P/J3-1 P/J3-4 E6 DEVELOPER RPL PUMP MOTOR

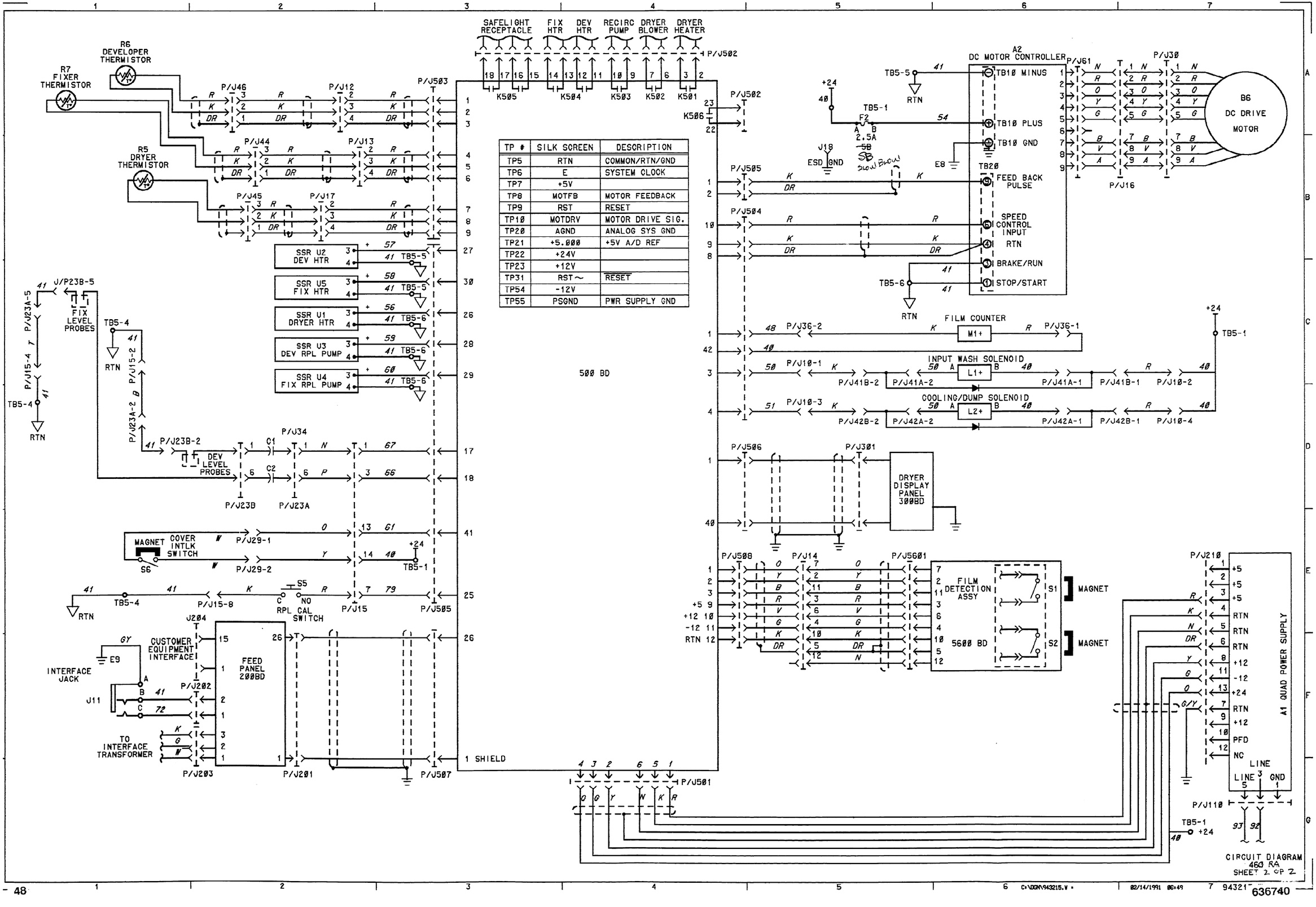
SSR U4 P/J3-9 P/J38-2 60HZ 50HZ B4 P/J38-1 P/J38-3 P/J3-6 P/J3-7 E6 FIXER RPL PUMP MOTOR

TB2-5 TB2-11 CB4 10A LOAD-C FL3 20A P/J40-4 P/J40-3 P/J2-4 P/J2-3 TB4-5 TB4-1

SSR U5 P/J6-7 R4 1200W INT O.T. P/J6-6 P/J6-4 E7 K504 P/J502-13 P/J502-14 FIXER HEATER

FL5 5A A1 QUAD POWER SUPPLY P/J110-5 F1 5A +12 -12 +5 +24 P/J110-3 P/J110-1 E10

CIRCUIT DIAGRAM 468 RA SHEET 1 OF 2



TP #	SILK SCREEN	DESCRIPTION
TP5	RTN	COMMON/RTN/GND
TP6	E	SYSTEM CLOCK
TP7	+5V	
TP8	MOTFB	MOTOR FEEDBACK
TP9	RST	RESET
TP10	MOTDRV	MOTOR DRIVE SIG.
TP20	AGND	ANALOG SYS GND
TP21	+5.000	+5V A/D REF
TP22	+24V	
TP23	+12V	
TP31	RST~	RESET
TP54	-12V	
TP55	PSGND	PWR SUPPLY GND

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DC Distribution

The quad power supply supplies the DC voltages used in the processor. It converts the incoming ac voltage into +5, +12, -12 and +24 V dc. This voltage is distributed to the following components:

- **200 Circuit Board (+5, +24 V dc)**

- **300 Circuit Board (+5, +12, -12 V dc)**

- **5600 Circuit Board (+5, +12, -12, +24 V dc)**

- **500 Circuit Board (+5, +12, -12 V dc)**

- **Drive Motor (+24 V dc)**

  The quad power supply provides +24 V dc through F2 to the drive motor controller. The 500 circuit board then sends 0 - 6 V dc to the drive motor controller circuit board. The voltage varies, depending upon the required speed of the drive motor.

  The drive motor controller circuit board provides 2 functions:

  (1) It controls the drive motor speed.

  (2) It sends feedback pulses to the 500 circuit board indicating the speed of the drive motor. The 500 circuit board uses this information to increase or decrease the speed of the motor until it is correct.

- **Solid State Relays (+5 V dc)**

  The processor uses 5 solid state relays to control the following components:

  (1) SSR-U1 - dryer heater
  (2) SSR-U2 - developer heater
  (3) SSR-U3 - developer replenishment pump
  (4) SSR-U4 - fixer replenishment pump
  (5) SSR-U5 - fixer heater

- **Electromechanical Relays (+24 V dc)**

  The processor uses 6 electromechanical relays to control the following components:

  (1) K501 - dryer heater enable
  (2) K502 - dryer blower enable
  (3) K503 - recirculation pump
  (4) K504 - developer and fixer heaters enable
  (5) K505 - safelight receptacle
  (6) K8 - dryer blower

  NOTE

  The processor uses the electromechanical relays mainly as enable relays, and the solid state relays as control relays. For example, the developer heater is enabled by K505, but SSR-U2 actually controls the developer temperature.

Health Sciences
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